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THE RESEARCH AND DEVELOPMENT OF CARTOGRAPHIC TECHNIQUES FOR THEMATIC MAPPING

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THE DD/I HISTORICAL SERIES

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THE RESEARCH AND DEVELOPMENT OF CARTOGRAPHIC TECHNIQUES FOR THEMATIC MAPPING

by

[redacted] (b)(3) (b)(6)

October 1971

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THE RESEARCH AND DEVELOPMENT OF CARTOGRAPHIC TECHNIQUES FOR THEMATIC MAPPING

I. Introduction

A. OSS Thematic Mapping Concepts

Thematic mapping, as a profession, was virtually non-existent at the beginning of World War II. * Major mapping organizations, such as the Army Engineer Reproduction Plant (predecessor to the Army Map Service), the Navy Hydrographic Office, the Coast and Geodetic Survey, and the Geological Survey, employed conventional methods of map production which had been established in World War I days. These leisurely patterns, set in the early 1900's, were little changed by 1940. Even with the outbreak of World War II, the service organizations met the increased demands placed on them for maps by greatly increasing their staffs and by inaugurating around-the-clock production, rather than by streamlining the old, inefficient methods.

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* A thematic map emphasizes a single subject, while omitting or subordinating all other data. The production of such maps is a highly specialized art, involving the interplay of thoroughly trained research cartographers and skilled technical cartographers and draftsmen. This report deals primarily with the technical aspects of thematic map production and touches on research only as it relates to production techniques.

The first OSS cartographers came to Washington with degrees in geography and little practical training in cartography. What cartographic training they had received was of the textbook variety and constituted a general knowledge of the conventional methods of map production. Production facilities and equipment available to them simulated the University cartographic lab environment. Despite this meager background they quickly realized that they could not produce the variety of thematic maps needed, with the speed and urgency demanded, by following conventional mapping standards and procedures. New concepts had to be developed immediately for thematic map production and thus the foundation was laid for what was to become the Agency's Cartography Division.

Production procedures on both the compilation and construction phases were drastically streamlined. Whereas conventional methods dictated a formal, hard-line approach, thematic mapping demanded a more informal, more open approach, especially during periods of great urgency. Conventional methods also called for voluminous manuscript instructions and specifications, while thematic mapping required only those specifications needed to adequately inform the draftsman. By

conventional methods, drafting was always performed on heavy metal-mounted strathmore boards with extreme accuracy and high quality workmanship; thematic mapping was executed on light weight, easy-to-handle translucent materials at a more realistic degree of accuracy and quality related to scale. Whereas conventional methods necessitated costly and time-consuming full-color press proofs for editing, thematic mapping editing was accomplished by examining the original drawings thus eliminating the need for a proof. The entire production process was compressed for the prime purpose of speeding up production to meet the pressures and deadlines of an increasing workload without increasing the number of personnel. One fundamental concept of conventional mapping was retained for overall efficiency -- that of separating research compilation and drafting. It was agreed in the early 40's, and it still holds today, that greater efficiency of production was achieved by totally separating these two basic phases of thematic map production.

With production procedures fairly well established, OSS cartographers began to develop new techniques to augment the new system. Investigation and research had to be performed in several basic areas to expand their knowledge and use of basic

drawing materials, inks and type. There was no specific unit established in the OSS Cartography Division to handle these investigations so specific assignments were made on an informal basis as the need arose. Results were generally successful, and the new system developed a rather high degree of sophistication for the period.

At the end of World War II, the OSS Cartography Division, Research and Analysis Branch, was transferred to the Department of State in anticipation of the establishment of a new intelligence organization. There it remained until 1947. During this period there was too little work for too many people, and it became necessary to improvise work to keep the cartographers busy.

An experimental Lab unit was informally established to investigate new cartographic techniques that had been developed by the major mapping organizations as a result of war pressures and to work up basic concepts on thematic map symbolization. In pursuit of this aim, visits were made to other governmental mapping agencies. One such visit to the Cartographic Lab of the Coast and Geodetic Survey was so impressive that the visiting cartographers strongly recommended a similar setup in any future thematic mapping organization.

B. United States Postwar Commitments Produce New Pressures for Thematic Maps

The advice and recommendations of the experimental Lab unit were heeded. When the Cartography Branch was transferred to the Agency in December 1947, its new organization included a cartographic lab. Subsequent US foreign commitments put extreme pressure on the Cartographic Branch to produce thematic maps to support Agency requirements. The rebuilding of Europe under the Marshall Plan, the imposition of the "Iron Curtain", the Berlin Airlift, the creation of NATO, the takeover of China by the Communists, the first Soviet nuclear explosion, and the Korean conflict were happenings that led to demands for more and more thematic maps to support briefings and to provide expanded graphic support to the economic, political, and military research and operational efforts of the Agency. The pressure to increase production continued, and it intensified the need for more efficient production procedures and techniques to meet these demands.

Throughout the history of the Cartography Division there was, for one reason or another, a constant shortage of draftsmen. The imbalance between compilers and draftsmen was cited regularly as a major problem in Division monthly reports in the

1950's, and the situation continued through the 1960's. Shortening the draftsman's time to complete an assignment was the only means of keeping abreast of the problem.

These compelling influences gave the impetus that led to the development of the procedures and techniques employed today and put the Agency's Cartography Division in its position of leadership in thematic map production.

C. The Four Periods of Technical Development

During the entire reporting period (1947-1970) cartographic research and development was given the highest degree of backing and support by Division and Office management. Office Directors, Dr. Otto E. Guthe (1947-1965), Mr. James A. Brammell (1965-1970) and Dr. John K. King (1970 -), and Division Chiefs, M (b)(3) (b)(6) [redacted] (1947-1965), Mr. [redacted] (1 (b)(3) (b)(6) 1970), and Mr [redacted] (1970 -), fully supported every move to keep the Agency's cartographic effort in the forefront. (b)(3) (b)(6) Despite this dynamic approach by management, the fact could not be altered that Lab effectiveness was always dependent on the ability, motivation, and imagination of the Lab personnel assigned to perform the investigations, research, and development.

Therefore, the history of the Cartography Division's efforts in this developmental field can be divided into four periods. Three periods related to the persons occupying the Lab position during these years. The fourth period occurred after the Lab, per se, was abolished for the lack of a suitable person to fill the position. Also during this final period, the Division's mission expanded so greatly that despite management's feelings regarding research and development, there was no alternative but to support critical production problems in preference to research and development. The four periods were: 1947-1954, 1954-1962, 1963-1964, and 1964-1970, with the most vigorous and meaningful development occurring during the second period.

During this entire interval the Division was constantly confronted with requests for maps which, because of their urgency and/or odd requirements, necessitated adjustments or modifications to the standard operating procedures of the time and continually tested its organizational flexibility. These ad hoc situations occurred hundreds of times over the years and significantly enhanced the Division's outstanding reputation for being able to produce the "impossible job" by the required deadline. Ad hoc procedures will be discussed in a separate section

and two projects, a model for the Special Assistant for Vietnam Affairs (SAVA) and a map for the [redacted] will be discussed in detail. (b)(1) (b)(3)

II. Chronological Development (1947-1970)

A. The [redacted] Era: A Period of Relatively Low-key Development (1947-1954) (b)(3) (b)(6)

1. A Cartographic Lab Becomes Part of the New Agency Cartographic Organization

In December 1947, the former OSS Cartography Division was formally transferred to the Central Intelligence Agency and became the Cartography Branch of the Map Division. The Branch was comprised of four Sections: three Research Sections responsible for performing cartographic research and manuscript preparation, and a Construction Section responsible for the technical aspects of map production. The latter contained a Drafting Unit, a Type Unit, and, most significantly, a Cartographic Lab. In August 1952, the Cartography Branch was elevated to a Division, and the Construction Section became the Development and Construction Branch, putting, as the name implied, further emphasis on research and development. Several years later the name was changed to the Technical Support Branch. To lessen the organizational confusion the Agency's cartographic organization will hereafter be called the Cartography Division.

The experience gained and the success achieved by the experimental Lab unit during the interim period with State proved beyond a doubt that a Cartographic Lab was critical to any future cartographic organization. Management, recognizing the value of cartographic research and development, formally included the Lab in the new organization. The Lab's responsibilities were: 1) to investigate and introduce new drafting and compiling techniques, materials, and equipment; 2) to develop training and working aids for compilers and draftsmen; 3) to develop new symbols and establish and maintain orderly symbol files; 4) to work with reproduction to upgrade the quality of printed maps; 5) to keep abreast of developments in the field of cartography; and 6) to train new personnel.

2. Lab Personnel Are Selected

The management of the Cartography Division discovered quickly that all research and development problems were not automatically solved by merely having a Cartographic Lab as part of the organization. Well trained, highly motivated, technically inclined cartographers had to man the unit to make the headway desired. The problem of finding suitable Lab personnel faced the Branch in 1947 and several times thereafter.

(b)(3)

A careful review of Branch personnel led to the sele (b)(6) tion of Mrs. [redacted] and Miss [redacted] as the first (b)(3) (b)(6) Lab "men". Mrs. [redacted] had been with the organization in (b)(3) (b)(6) OSS days, and Miss [redacted] was with the Division of Geography (b)(3) and Cartography, Department of State, before joining CIA. B (b)(6) had thorough training and experience in all phases of thematic map production. In addition, both had an artistic flair which was of considerable value for the informal program in mind at the time. As was to be learned later, neither Mrs. [redacted] nor (b)(3) (b)(6) Miss [redacted] had special technical competence, so projects (b)(3) (b)(6) which involved the designing and constructing of mechanical aids had to be abandoned. They did, however, accomplish much by producing compilation and drafting aids during their tenure.

Mrs. [redacted] resigned from the Agency in May 195 (b)(3) (b)(6) and Miss [redacted] was promoted to compiler and transferred t (b)(3) (b)(6) a Research Compilation Section at approximately the same time, leaving the Lab unoccupied for a short period.

(b)(3) (b)(6)

In mid-1952, Miss [redacted] and Mr. [redacted] (b)(3) [redacted] were chosen to take over the Lab responsibilities. Bo (b)(6) were cartographic draftsmen with several years experience. (b)(3) (b)(6) Miss [redacted] had an art background, and Mr. [redacted] had been

(b)(3) (b)(6)

called upon numerous times to assist in jobs that went beyond his drafting responsibilities. They were considered the best choices at the time to keep the Lab alive. Miss [redacted] (b)(3) (b)(6) devoted her major effort to training new personnel, which will be explained later. Mr. [redacted] continued to support the Branc(b)(3) (b)(6) on assignments that fell beyond normal drafting responsibilities and were turned over to the Lab for processing. The [redacted] (b)(3) (b)(6) [redacted] era produced very little. Miss [redacted] resigned from(b)(3) (b)(6) the Agency in October 1953. Mr. [redacted] remained as the only (b)(3) (b)(6) Lab man until he resigned in February 1954.

3. Problems of Development During This Period

The full potential of a Cartographic Lab was never realized during this period which spanned the late 1940's and early 1950's. Part of the problem lay in the Lab personnel who were just not capable and imaginative enough to meet the real challenges that confronted them. This, of course, was not fully realized at the time but became apparent in retrospect.

The rest of the problem lay in the fact that not all available Lab time was devoted to pure Lab-type assignments. The Lab was assigned at the outset the responsibility of training new

personnel, both draftsmen and compilers. Lab personnel were also continually tapped to support regular map production.

The training program was developed to indoctrinate all draftsmen and compilers into the specialized world of thematic mapping and to give appropriate training to enable them to make the transition to full production with the least amount of stress. A full line of projects was developed to carry the draftsman from the most elemental task to the most complicated. High levels of quality had to be achieved for each project before passing to the next. All new draftsmen, even those with considerable prior experience, were put through the program to assure that they understood clearly what was expected of them.

All compilers were also put through the same program but for a different reason. The output of the compiler was a manuscript map from which the draftsman prepared his final drawings. Although he was not preparing final copy, the compiler's work on this manuscript had to be succinct and unambiguous to avoid any possible misunderstanding by the draftsman. By going through the series of drafting projects the compiler improved his ability to prepare the manuscript. He also gained an excellent appreciation of the skill and exactitude required of the draftsman

to meet his specifications. Additional work was given to the compilers on type recognition and selection and the preparation of concise specifications and type orders.

The program required an average of eight weeks to complete and demanded almost full time and attention from the Lab instructor. Very little Lab work could be undertaken while the training program was underway and, with many new persons entering the Division during this period, the program was conducted frequently.

Regular production at this time was building steadily because of the demands being placed on the Cartography Division. There was always an acute shortage of drafting help. Because of the relatively low priority of its work, aside from training new personnel, the Lab was repeatedly called upon to supply assistance to the Drafting Unit, usually by assigning the second person but quite often both Lab persons. When this occurred, Lab projects that happened to be underway were naturally delayed. The Lab was also a catchall for unique odd jobs so even the relatively little time available for Lab work was further diluted with these numerous small assignments.

During this period the time available to further true Lab-type efforts was well below 50 percent of the total. These were years of "getting up steam" for the Branch. As experience was gained under the new organizational setup, many areas of potential need for Lab support were recognized. Prime needs were considered, and those projects were selected which coul(b)(3) (b)(6) be readily handled by the [redacted] or [redacted] (b)(3) (b)(6) teams. They included the preparation of line-weight guides, type guides, printing color guides, handbook pages, and symbols. Although not research projects, they were still in the realm of Lab assignments, the results of which would save many hours of compilation and drafting time and, in turn, greatly increase the efficiency and quality of the general production scheme.

4. Significant Lab Accomplishments During This Period in the Form of Cartographic Aids

As stated above, the production of thematic maps was divided into two separate operations: 1) the preparation of a manuscript by the research compiler who was basically a geographer/cartographer, trained to extract the substantive details from various sources; and 2) the production of the final drawings by the skilled draftsman who was versed in the technical aspects

of map construction. Under this arrangement, guidelines were an absolute necessity in order to harmonize the production of a number of compilers, to establish uniform standards, and to allow compilers to communicate with the draftsmen. Essentially, the need to coordinate the production efforts between the two groups was the impelling force behind the development of guides of all kinds.

a. Line-weight Guide

The line-weight guide was developed and prepared to ease the compiler's problems in designing the map. With this visual aid, which depicted page-wide samples of all line weights available to him, the compiler visually checked the guide against the manuscript to make his selection. The reverse side of the page carried samples at 25 percent and 50 percent reductions to demonstrate the effect of reducing the originals. The draftsman, in turn, used the guide in selecting pens to match the specified weights when preparing the final drawings.

The Leroy lettering point was used to achieve lines from 0.012" to 0.15". Numerous samplings of each point were made. Tests with a 40X shop microscope showed that the same

numbered points produced a variety of line weights -- off but a minute fraction, but significantly enough to upset a close balance on occasion. The average of each point was then determined, and this became the weight of the line that appeared on the guide. Once the guide (Figure 1)* was distributed in paper and transparency form, virtually all conflicts concerning line weights between draftsman and compiler vanished.

Several years later a line-weight guide for the Pelikan pen was issued to supersede the Leroy guide.

b. Type Guide

The type guide (Figure 2) was prepared primarily for use by the compiler in selecting styles and sizes of type in designing the map. The Lab designed each page to show all the available sizes of an individual style by showing words in all capitals and in capitals and lower case, plus numerals at each size. In addition, the complete font (all letters, numerals, and punctuations available) was shown in a small size. The reverse side of each page also contained sample reductions of

* All figures appear at the end of the text.

25 percent and 50 percent for added usefulness. The type guide was used by the draftsman to verify the type against the type order prepared by the compiler.

Additional type styles were added to the guide over the years, but the basic format, which had been excellently designed, did not change.

c. Color Guide

This guide (Figure 3) was unique in its conception since nothing similar had ever been designed specifically for the compilation and construction of thematic maps. It was, in a real sense, a visual comparator for the compiler to use in making design judgments in the selection of lines, symbols, tones, and type as related to color.

The Lab designed a page which contained a carefully selected group of symbols, lines, patterns, tones, and type, arranged in such a way as to provide the compiler with a visual image of what he could expect to get if he chose one, or a similar item, when printed in the color of his choice. Since he had this same page in all colors, the compiler had the means to visually support his cartographic design judgments.

Like the two other guides, the color guide was also a help to the draftsman in type positioning. By referring to the guide he was able to determine the hierarchy of overprinting based on color and screen as selected by the compiler.

The color guide went through two subsequent revisions between 1950 and 1966. Each revision, however, adhered to the original basic design concept to give the cartographer a means to make intelligent judgments.

d. Symbol Guide

The use of preprinted symbols to replace the tedious, time consuming hand-drafted variety began in OSS days. From the early 1940's to 1952 a sizeable collection of abstract, pictorial, and military symbols had accumulated. They were extremely useful and had saved an incalculable amount of manpower in that time. It was, however, a hodgepodge, unorganized collection. In line with the development of a more professional, viable organization the Lab was directed to give order and direction to the symbol problem.

To simplify symbol use, the Lab carefully determined standard sizes, and, where necessary, symbols were

enlarged or reduced to fit these standards. Symbols were numerically indexed. Sizes were assigned letter designations. Once these standards were instituted the preparation of symbol pages began. The resultant guide (Figure 4) became a series of symbol pages organized to provide better communication between the compiler and draftsman and to provide a visual image of the various available symbols in their different sizes to aid the compiler in his design efforts.

During this early period of development, continued requirements for additional symbols were turned over to the Lab. As these new symbols were made part of the file, new pages were produced to keep the system as up-to-date as possible.

To assist the draftsman in his efforts, a file was established to make locating the preprinted copy a simple operation. In connection with it, display panels were produced for location and identification.

The symbol file remained in this form until a major revamping was undertaken during the next period of Lab development.

5. Other Lab Accomplishments During This Period

Information on various cartographic developments was being received by the Cartography Division through personal contacts with cartographers of other agencies (foreign and domestic) and at professional meetings such as the American Congress on Surveying and Mapping (ACSM) and the Visual Communications Congress (VCC) conventions. Even though the bulk of available Lab time went into preparing and maintaining the guides, some effort was put into those new developments which were deemed important enough to be of immediate benefit to the Division. Two of these were the testing and introduction of the German Pelikan pens and inks and the introduction of plastic as a drafting and compilation medium.

a. Pelikan Pens and Ink

As compared to topographic mapping, where an 0.010" line was considered a heavy line, thematic mapping required the use of lines up to 0.15". Obtaining these heavy line weights on a consistent basis was a problem. Leroy lettering points were used by the draftsmen to obtain lines from 0.010" to 0.15" in weight. The practice dated back to early OSS days.

Leroy pens were difficult to use because of their design and their poor quality of construction resulted in varying line widths from identically numbered points. However, they were the only pens available to do the job required.

In the late 1940's the Gunther-Wagner Company of Germany introduced the Pelikan tubular "fountain" drawing pen with a variety of nibs. A complete set of these pens and points was procured by the US Geographic Attache in the area, and tests were made to determine their possible substitution for the unhandy Leroy points.

At first glance the new pens gave a feeling of confidence. They were constructed with typical high quality German craftsmanship, and they performed to match their appearance. The ink-containing barrel completely eliminated the continual refilling required by the Leroy points. Ink flow was excellent, and the rate of flow could be regulated by exchanging feeds and could be set to match the speed of individual draftsmen. Cleaning the Pelikan nibs was very simple. A small wire insert was put in place after use, and a day's supply of used nibs could be cleaned at the end of the day by simply running water through them. Most important, the uniformity of line was

excellent from one point to another, attesting to the superior manufacture. The Pelikan pens were introduced as standard equipment to replace the Leroy pens, and the quality of inked drawing immediately improved.

The Gunther-Wagner Company also produced a Pelikan ink in several varieties. Samples of these were tested, and the Pelikan Black No. 17 proved far superior to the Higgins ink then in use. After the Pelikan ink was substituted for the Higgins on a regular basis, occasions of graying lines were experienced. These occurrences were disturbing because they created lost motion on the draftsman's part to retouch the gray lines. Experiments proved that by further concentrating the ink by air evaporation, a much more dense line was achieved. This practice became a standard procedure each time a new supply of ink was introduced into the drafting operation. (The evaporation, however, was hit or miss until Mr. [redacted] (b)(3) (b)(6) future Lab Chief, later approached the problem on a more scientific basis and established a definite procedure. The Pelikan ink was evaporated in a specially constructed pan to a specific gravity of 11.5° minimum to 12.5° maximum Baume. This procedure consistently resulted in high quality linework).

b. The Introduction of Plastic as a Drafting Medium

In the early 1950's the Cartography Division was introduced to a new vinyl plastic material, trade named Dyrite, by Mr. Samuel Sachs of the Coast and Geodetic Survey. The raw base of Dyrite was produced by the Bakelite Corporation and processed by the Direct Reproduction Corporation of Brooklyn, New York. Processing the 0.010" thick plastic involved running the raw material through the same series of graining processes used for graining zinc lithographic press-plates, with glass marbles and sand -- the longer the graining and the finer the sand, the more delicate the grain. Samples with various grades of grain were purchased from the New York company, and a series of tests were begun by the Lab.

At this time, a chemically grained Kodak acetate base material was being used for compiling and drafting. It was the only material of its kind at this time. Being nonstable in nature, it caused constant problems of registration (the exact matching of one drawing to another) by its contraction and expansion. Dyrite was relatively stable. The minute changes in its size were insignificant when compared to acetate. Inking tests

showed that the Pelikan Black No. 17 produced high quality linework. Dyrite's hard and durable surface made corrections simple by permitting removal of inked lines with a sharp X-Acto knife, and this extra advantage would save considerable drafting time over the difficult-to-correct acetate. Dyrite became the standard medium for drafting and compilation and replaced all other media. Over the next 15 years several companies introduced competitive products which were tested as possible replacements for Dyrite. In every instance, Dyrite proved superior. In 1969, however, a new material, Keuffel & Esser Stabilene Drafting Film, which vied favorably with Dyrite, was put on the market but, because of its extra expense, its use was still in question at the end of this reporting period.

6. Other Development and Construction Branch Personnel Become Involved in Experiments

During this period, with production ever increasing, it became very important not to lose sight of developments at other agencies. Key Branch personnel made occasional visits to other organizations to assure that the Division was at least aware of happenings in the cartographic field beyond the limited capability of the Lab. Contact with Mr. Sachs' Lab at the

US Coast and Geodetic Survey (USC&GS) was kept active and proved to be invaluable. Two new developments were observed there which later made significant impacts on the Division. They were a new method of registration by means of a punch hole and pin and a revolutionary way to produce lines by means of scribing (engraving) on plastic.

a. Introduction of a Punch Register System

What is registration and why is it so crucial in cartographic production? In the cartographic production process, a manuscript worksheet is compiled which contains in graphic form all the elements that combine to make up the final map. The manuscript is usually prepared in colored inks or pencils to distinguish one element from another, and the worksheet can be viewed as a complete map in the "rough" stage of production. In order to print multiple paper copies of the manuscript worksheet, the draftsman, following specifications supplied by the compiler, actually separates each element onto a separate drawing. For example, the international boundaries are inked on one drawing, the railroads on another drawing, the coastline and rivers on another drawing, the open-water areas on another, etc.

The sucess of the entire system, from compilation to reproduction, depends on how accurately the separation drawings are matched to each other throughout the process, the ultimate aim being to reproduce the original manuscript on paper in multiple copies by means of the drawings with every element in its exact position relative to all other elements.

During the drafting process, each drawing is affixed with either a series of four corner registration marks aligned to the corners of the neatline (the fine borderline of a map) or three cross registration marks positioned at top center and left and right center beyond the map image for maps with exceptionally heavy or no borderlines. While acetate was in use as the prime drafting medium, the continual changing of the material, because of its instability, forced the draftsmen to shift these registration marks repeatedly. These marks were in turn used by the reproduction plant to register the negative before transfer to pressplate and from pressplate to printed copy. By the time a long-term map was completed it was anyone's guess as to how the individual drawings would register on the final paper-printed copy. When plastic was introduced, the problem was deemed under control because of the excellent sta-

bility of the new material and because, once positioned, registration marks on it rarely had to be shifted.

From the very beginning, separation drawings were secured to the manuscript and to each other by means of drafting tape. It was not uncommon in the old days to see every compiler's and draftsman's work area littered with hundreds of pieces of drafting tape as a result. In the course of producing a multicolor map, the draftsman, in performing his job, and the compiler, in checking the draftsman's work, shifted manuscript and drawings many, many times to achieve various combinations. Each shift required untaping, reshuffling, and retaping -- a costly and time consuming process. The USC&GS's new punch system completely eliminated all this lost motion and effort.

The new system involved selecting the number of sheets of plastic required for a given job and placing them over the manuscript. With a 1/4" round-hole hand punch, two widely spaced holes were punched in the open margin at the top and through all the sheets simultaneously. Two rivets, slightly larger than the punched holes, were supplied and slipped into the bottom sheet of any combination. Subsequent sheets were merely positioned over the protruding rivets, and the pieces

were in perfect registration with each other. There was no limit to the amount of juggling and shifting that could take place without jeopardizing the accuracy of the registration.

Testing and developing in the Division was performed by Mr. [redacted] then Chief of the (b)(3) (b)(6) Development and Construction Branch. He initially purchased a common ticket punch from a local hardware store and found suitable rivets at a machine shop. When the system was introduced in 1950, the results were immediately felt, not only in the saving of manpower by eliminating tape registration, but in the upgraded accuracy of registration of the printed images. A few years later several commercial hand punches and brass eyelets were purchased to improve the operation. This system remained in use until 1967, when the intermixing of various plastic base materials having varying degrees of stability forced a change.

b. <u>Initial Contact with Scribing</u>

The second major advance in cartographic production discovered at USC&GS during this period was plastic scribing. Mr. Sachs had modified instruments used to engrave on glass by

substituting ordinary steel phonograph needles for diamond cutters. The phonograph needles were then honed to the desired line weights by a series of specially designed sharpening jigs. Mr. Sachs formulated a paint coating which he whirled onto sheets of clear vinyl plastic. The manuscript image was then transferred, in reverse because he was creating a negative, onto the coated surface by a photographic blueline process. He then proceeded, as in conventional drafting, to scribe (engrave) the specified elements on each sheet of plastic. The quality of the scribed linework was outstanding in its uniformity. Even at 40X enlargement the linework quality was still excellent. The implications of this technique were tremendous. It took many years to train a draftsman to produce top quality ink-drawn linework which would approach the scribed quality. With scribing, it would require substantially less time to become expert. Top draftsmen were still hard to come by, and increasing the quantity and quality of the Drafting Section was a prime goal.

Shortly after this initial contact in 1952, Mr. [redacted] (b)(3) (b)(6) [redacted] Deputy Chief of the Development and Construction Branch, spent a week at USC&GS working with Mr. Sachs to learn the details of the new process. He returned to his Division

greatly enthusiastic about the potentials of scribing but with the recommendation that nothing be done in-house until Mr. Sachs had refined his system which was to become a revolutionary development in the world of cartography.

7. Recapitulation of the Period

This initial period saw the Cartography Division develop into a highly professional and specialized thematic mapping organization. Although not revolutionary, most of the technical developments during this period were significant contributions toward the furthering of this professionalism. The production of cartographic aids in the form of compilation and drafting guides were major efforts, and the guides stand today because of the thoroughness of thought and design put into them.

The introduction of Pelikan pens and ink and the discovery of Dyrite plastic as a drafting medium enabled the Drafting Section to increase both the quality and quantity of its production while faced with an ever increasing workload.

The punch register system did introduce a minor revolution in the way drawings were handled during the construction and editing process. Its introduction led to the saving of countless hours of drafting and compilation time.

Although recognized as having future potential, scribing did not become a significant factor during this period. The groundwork was laid, however, for a later deep involvement in the process and for the Cartography Division actually taking the lead in developing certain phases of the system.

B. Period of Vigorous Development (1954-1962)

(b)(3)
(b)(6)

1. Mr. [redacted] Takes Over the Cartographic Lab

After Mr. [redacted] resigned in February 1954, the Car (b)(3) (b)(6) graphic Lab remained unoccupied for several months. This was a period of progress at the major mapping organizations, and it was imperative to keep the Lab operation active to keep abreast of these developments. A thorough search of Division personnel led to the selection of Mr. [redacted] to head the Lab. (b)(3) (b)(6)

Mr. [redacted] entered the Agency as a cartographic dra (b)(3) (b)(6) man in 1950. His success as a draftsman enabled him to move into the Cartographic Aid Section in the Development and Construction Branch. The Section had been created in 1953 to handle the numerous jobs that did not fall into the regular production scheme of the Division. Its personnel had to be technically skilled and innovative, and Mr. [redacted] did an excellent job in that Section. He moved to his new position in July 1954. (b)(3) (b)(6)

2. A Broad Lab Program Is Formally Approved

Mr. [redacted] began immediately to review the previou(b)(3) (b)(6) efforts of the Lab and in a short time, in conjunction with the Deputy Branch Chief, submitted a challenging program of research and development. This was the first time that a definite Lab program had ever been established to formalize directions and goals. The seven-point program called for a major effort to improve the quality of the final product, increase productivity by introducing new time-saving techniques and procedures, and improve the welfare of Division employees by introducing aids and equipment to ease their burden.

The first point of the program called for establishing a meaningful schedule of contacts within the cartographic community to keep abreast of pertinent developments. Contacts were quickly established with all the local major mapping organizations and producers of graphic materials and equipment. The Branch was confident that any new developments, even in their infancy, would be known by the Lab. It was not uncommon in those days for the Lab to be testing a new product well before it was put on the market. Three prime local contacts were developed or expanded: Mr.

Samuel Sachs*, USC&GS, already a good friend of the Division; Mr. Lionel Moore, US Geological Survey (USGS), Headquarters Department; and Mr. John Scott, USGS, Atlantic Field Office. A few years later, in 1958, Mr. [redacted] visited the Aeronautical (b)(3) (b)(6) Chart and Information Center (ACIC), St. Louis, Missouri, where he met Mr. Robert Sovar, Chief of the ACIC Cartographic Lab. This contact became invaluable over the years, and several subsequent visits were made to St. Louis to work more closely with Mr. Sovar and his men.

Professional meetings became a valuable source of information and Mr [redacted] attended trade fairs, Visual Communica- (b)(3) (b)(6) tion Congresses, and ACSM Conventions whenever and wherever they were held.

The second point of the program specified the development of new techniques and procedures and the training of Division personnel to handle them properly. As the search for new ideas began to pay off and new techniques and materials were discovered, it became clear that introducing these into the production scheme

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* Mr. Sachs left government service around 1956 to become Vice President of the Direct Reproduction Corp., New York.

was another problem. The Lab then established a standard routine of thorough testing under Lab experimental conditions, production testing under the control of the production unit but monitored by the Lab, then developing a new procedure or modifying the then current procedure to accept the change. As an immediate follow-up, all personnel involved were trained in the Lab to properly understand and handle the change.

The third point of the Lab's program proposed the issuing of reports and Technical Information Bulletins to keep Division personnel knowledgeable. Quarterly reports were prepared for the Chief of the Cartography Division showing the status of all projects, listing trips and significant contacts, and any other points of interest. In an effort to keep Division personnel informed and to increase general technical knowledge, a series of Technical Information Bulletins was issued. A wide range of subjects was covered by these Bulletins, from Soviet Scribing Plastic (February 1960) to Colored Pencils for Use on VanDyke Film (March 1964) to Deep-etch vs. Surface Plates for Map Reproduction (June 1960).

The fourth point stipulated that a comprehensive record of experiments, successful and unsuccessful, be maintained. In

contrast to the previous era when practically no records were kept, the [redacted] era maintained a comprehensive file of all ex- (b)(3) (b)(6) periments. The saying at the time was that a full cabinet of failures and unsuccessful experiments versus a small cabinet of successes proved that the Development and Construction Branch was doing its job to the fullest.

The fifth point called for establishing a workable file of techniques, material, and vendors. The buildup of technical knowledge and information, to be useful, had to be cataloged for easy reference and retrieval. The Uniterm filing system was investigated, found to be ideal for the Division's requirements, installed and maintained by the Lab.

The sixth point was a commitment to be responsive to Division needs and introduce cartographic aids and equipment to further the effectiveness of the production operation. Needs were continually surveyed, and a number of specifically designed and constructed aids and pieces of equipment were introduced to support the specialized production of thematic maps. These will be discussed later.

The last point of [redacted] seven-point program conc (b)(3) (b)(6) the training of new personnel in the Division. The Lab retained

the responsibility to train all new personnel. Training given during this period, however, was more thorough because of the greater technical knowledge and instruction of the Lab Chief.

3. The Cartographic Lab Becomes a Two-man Section

Although Branch production continued to increase by virtue of greater demands placed upon the Division and there was an ubiquitous shortage of drafting support, the Lab was made a two-man Section between 1955 and 1959. The worth of a producing Lab made itself felt in all areas of Division production, and the value of the additional manpower to support this effort was fully recognized by Division management.

The added manpower allowed Mr. [redacted] to allot the (b)(3) (b)(6) bulk of his own time to the investigative and reporting areas of the Lab operation, while his assistant, under his close direction, performed the tests and production phases of the job and also assisted with training. (b)(3) (b)(6)

Mrs. [redacted] (1955-56) and Mr. [redacted] (b)(3) (b)(6) (1957-59) were both assigned from the Drafting Section. Mrs. [redacted] prime contribution was her work in developing and (b)(3) (b)(6) testing the scribing techniques which were subsequently introduced

into the production process. She resigned from the Agency in July 1956. Mr. [redacted] major contribution was his complete (b)(3) (b)(6) revamping of the symbol files.

During this two-man period, the pressures of production often forced the Lab assistant to forego his Lab duties and return to the Drafting Section to support a critical backlog of production. Such pressures eventually forced the Lab back to its one-man status in 1959, when Mr. [redacted] was returned to the (b)(3) (b)(6) Drafting Section to resume full production.

4. Significant Accomplishments of This Period

a. Scribing Procedures Established for Thematic Mapping

Although the basic principles of map production were similar for both topographic and thematic mapping, individual phases and the philosophy behind their operation were vastly different. Scribing was developed by a topographic mapping agency whose draftsmen worked for weeks, even months, to complete certain complex drawings such as contours and culture. The basic system developed in the early 1950's was to allow for continuous, long-term production at greater speeds and higher quality than ink drafting. Thematic mapping construction, in contrast,

required only relatively short drafting operations. Maps which required several days for individual drawings were considered major projects. The topographic draftsman was assigned a certain area of production, so that scribing drainage, if it were his assignment, would be his full-time job. The thematic draftsman was responsible for the entire production of an assignment; scribing drainage would be only one part. He would also scribe the other elements -- boundaries, transportation, etc. -- as well as prepare tone drawings and place all typography. Therefore, the fact that a workable system of scribing was developed for thematic maps, despite the basic problem of sporadic use, must be considered a major breakthrough.

After Mr. [redacted] first contact with Mr. Sachs (b)(3) (b)(6) revolutionary idea in 1952, the development was observed by the Branch until Mr. [redacted] took over the Lab in 1954. When Mr. (b)(3) (b)(6) [redacted] began his local investigations he heard from several (b)(3) (b)(6) sources about a Swedish scribing technique which sounded very similar to the USC&GS development and which was being hailed as a cartographic revolution. As the Lab later learned from Mr. Sachs, he had encountered extreme difficulty convincing his own agency and the other major agencies of the value of plastic scribing.

His demonstrations and time-saving estimates were virtually ignored. However, the official Swedish mapping organization, Esselte, had heard of this new development and invited Mr. Sachs to Stockholm for several weeks to demonstrate the system. The Swedes immediately recognized the value and potential of scribing, and they began a changeover from hand-drafting even before Mr. Sachs left. As the months passed and scribing became accepted at Esselte, Americans, who often visited this dynamic organization, brought home stories of the amazing Swedish idea called plastic scribing, when, in fact, it was an American idea to begin with.

In the mid-1950's scribing was being accepted by all the major US organizations, its potential finally being recognized. The Lab procured a set of instruments (gravers), point sharpening tools, and, of course, the ordinary phonograph needles. Using coated plastic from USC&GS as a test base (no commercial scribing material was available at that time), the instruments were put through a series of experiments.

The most critical part of the system, as it developed, was sharpening the phonograph needles and then maintaining the line weight during the scribing operation. A special sharpening jig which put a precise 45° rake angle at the base of the needle was

purchased. This beveled needle in turn was placed in another jig and rotated on a fine sharpening stone until the desired line weight (width) was achieved. This was by no means the end of the operation, for the needle required continual examination and resharpening during the scribing operation.

Contrary to what one would think, the scribed line became finer, not broader, while the scribing was in operation. This anomaly occurred because of the coarseness of the coating, and the draftsman had to repeatedly examine his scribed line with a microscope to determine when to rehone the point to its original weight. This procedure was to have an adverse effect on the acceptance of scribing by the Division.

In early 1955, using the USC&GS coated scribing plastic and the above needle sharpening techniques, two drawings of the NIS base map of Chile, drainage and transportation, were scribed in negative form on an experimental/production basis by the Lab. The results were exceptional, and, despite the extra time required to maintain the scribing needles, time tests showed an appreciable saving in man-hours over ink drafting. The scribed negatives were then converted to positives by the Reproduction Plant and became part of the regular job.

About this time Keuffel & Esser sent the Agency samples of two new scribing materials they were planning to introduce. One was a white coating on a new plastic base called Mylar. The other coating was rust in color on the same base. Scribing quality on both proved to be excellent.

The Division had a long-established procedure of compiling and drafting for reduction to final copy size. In the early days, this was done to refine poor linework and type quality, but even as skills to produce high quality hand-drafting increased and type quality improved, the procedure remained the same. The Lab found that by using the white Scribecoat (K&E's trade name for its scribing material) and backing it with black paper, a positive drawing in effect was achieved that could be handled and photographed the same as a hand-drafted original (Figure 5). Furthermore, the white material was translucent, and the draftsman was able to trace the manuscript by subduing the overhead lighting, thus eliminating the blueline transfer of the manuscript to the scribing base. This then became the system which was recommended and introduced into the construction of thematic maps.

A scribing training program for all the draftsmen and an indoctrination for all compilers was carried out by the Lab. White scribecoat and several new scribing instruments were purchased. The Lab spent many weeks sharpening sets of needles to match the standard ink line weights established by the Division, and the complete package was turned over to the Drafting Section as operational -- but the system failed!

The original plan was to introduce scribing slowly, and it was to be employed only where a marked saving of time would be achieved. As a result of this decision, scribing was used only occasionally. This was its downfall, because the draftsmen found that to maintain their sharpening skills they required more than a sporadic chance to scribe. They simply lost the touch and, for the most part, it took more time to regain the touch than to hand-draft the element in question. Trying to force the issue did not overcome the problem. The draftsmen built up a barrier against scribing, and it looked as though this great potential was being lost.

Scribing limped along for the next two years as a technique which was used for the exceptional rather than the routine job. A few draftsmen recognized the value of the technique

and accepted scribing as a necessary evil, so several jobs were processed during this period. Even with its faults, scribing was ideally suited for preparing special straight-line grids, and it was used whenever a request for one of these was accepted. One such grid, produced in conjunction with Mr. [redacted] the Agency's chief architect, became the base (b)(3) (b)(6) on which the new Headquarters Building was planned and designed, and it remains in use today.

During a routine contact with the Engineer Research and Development Labs at Fort Belvoir, Virginia, in the spring of 1958, Mr. [redacted] learned of a new British sapphire scribing (b)(3) (b)(6) cutter being tested there. The cutter had arrived only a few weeks before, and it had already scribed over 10,000 feet of line with no change noted in line weight. The find looked promising. Mr. [redacted] checked with Mr. Sachs, who had since left gover- (b)(3) (b)(6) ment service to become associated with the Direct Reproduction Corporation, New York, and discovered that Direct Repro was already negotiating with the British firm to distribute Astrascribe (tradename) products in the United States. Mr. Sachs agreed to send the Division a test packet of gravers and sapphire cutters to begin tests, and these were received in May 1958.

Results of these tests proved excellent. Each light weight plastic graver was designed to hold a specific cutter and, once this was installed and adjusted, required absolutely no additional maintenance. It was agreed then to set up one battery of gravers, each holding a standard line width, and production test the system. The sapphire cutters did the trick. The draftsmen, not needing to be concerned with anything more than selecting the proper line weight, were enthusiastic about the development and looked for instances to use scribing. The system was a total success and almost immediately changed a dismal outlook for scribing to one of immense potential. Several more sets of gravers, including swivel gravers to produce lines of over 0.015", were purchased and prepared by the Lab. These were in turn introduced into the operation.

The first year of sapphire cutter use saw an increase in scribing from almost zero to approximately 30 percent of all linework produced. The following five-year period saw a further increase to well over 50 percent. By 1965, virtually all single lines were produced by scribing, except lines over the 0.032" weight (approximately 10 percent of the total) which were still inked by Pelikan pens.

In 1959 the Lab came up with the idea of multiple lines scribed by specially milled cutters. Double-lined scales and neatline and border combinations (Figure 6) were obtained from special cutters which Direct Repro ordered from Great Britain.

Many man-hours were saved by the use of the rigid, swivel, and combination-line sapphire cutters and white scribecoat to perform positive scribing, but more important, training a draftsman to achieve the highest quality workmanship was accomplished in a matter of weeks rather than the years it formerly took to train a draftsman to produce quality work by ink drafting. The thematic mapping production process had truly witnessed a revolutionary development. The Agency's Cartography Division was the first in the United States to introduce sapphire scribing into its operation. Even after many years of marketing, and as late as 1968, the major mapping organizations retained the steel phonograph needles. Their reason for not converting was that of expense, but each of these organizations had several persons assigned full time to sharpen needles and maintain instruments, itself a costly, time-consuming operation. Agency cartographers and draftsmen regarded this as a case of false economy.

Several attempts were made during the early sapphire scribing days to introduce negative scribing, but they were unsuccessful because of the difficulty of transferring the manuscript image to the scribing material and the need to handle typography as additional positives when scribing negatives. These difficulties were eventually overcome when K&E began to market yellow scribecoat. The Lab tested the possibility of performing scribing on this translucent material, which was in effect negative scribing because the coating was actinically opaque, then applying type directly to the yellow scribecoat as was done with the white scribecoat. The reproduction negative was obtained by photographing the yellow scribecoat through a filter to drop the color and hold the linework and type.

The process worked but there was no real advantage over the positive scribing until efforts were made to process more jobs on a 1:1 basis, i.e. compile, draft, and reproduce to paper copies at the same size, with no reduction of the image. The old adage, reduce to refine, was no longer applicable in the age of scribing. Extremely high quality linework could be achieved at any complexity with any combination of line weights. Therefore, to realize the full advantage of scribing, which was primarily to

produce a negative, the concept of 1:1 became established,and, as an added advantage, it saved substantial compilation and drafting time by reducing the amount of lines which had to be compiled and drafted.

Under the 1:1 process the yellow scribecoat was handled the same as described above. The type negative was obtained by photographing the image through a filter, the scribed lines disappearing against the copy board. The original scribed negative and the photographed name negative were then combined by double exposure to the press plate. This procedure added to the reproduction time, but there was a considerable overall saving of Agency manpower.

The yellow scribecoat technique prevailed until 1960 when K&E, which was rapidly taking over the commercial scribing market, introduced a new rust scribecoat containing a diazo sensitized coating (exposed by ultraviolet light and developed in ammonia fumes). Subsequent Lab tests determined that by modifying the compilation technique from inks to pencils, the manuscript image could be readily transferred to the new Helio

scribecoat (Figure 7) by exposure from black light fluorescent lamps and developed in a "pickle jar".*

This was a period of intense activity in the Lab, and several major developments were underway concurrently. Of significance to the introduction of the Helio (sensitized) scribecoat were the facts that intermediate reproduction facilities were being added to the Division's production process, and recommendations to switch from pen-and-ink to pencils had already been made to compilation to ease the burder there. The processes involved in handling Helio scribecoat were very close to being available at that time. These will be discussed in detail later as separate developments.

Helio scribecoat changed the entire scribing procedure by mid-1961. The manuscript prepared by the compiler was transferred in reverse by the diazo process. The draftsman proceeded to scribe the individual elements in negative form as specified. At this point, film positives were created from the

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* The name given to any portable container in which diazo materials are developed by adding a few drops of liquid ammonia and inserting material. Development is controlled by visual inspection.

scribed negatives on polystyrene film via the regular reproduction process or on Kodak washoff film by the draftsman (this process will be described later). The set of positives was then completed by the draftsman with the addition of type and any other items specified. The result was a set of positive originals which were forwarded to the reproduction plant for processing under normal procedures. In essence, the scribed negatives were only a means toward achieving the set of positives, but the time saved and the quality obtained made the scribing process extremely valuable. This procedure remained basically unchanged throughout the remainder of this reporting period except for one advancement in wide-line scribing which will be detailed later.

Scribing was indeed one of the historic advances made by the Division, and it became one of the prime factors permitting the Division to increase its production significantly without an increase in personnel. The most important advantages of scribing, as it was modified to support thematic map production were: it was at least three times faster than ink drafting; the quality of the final product was greatly enhanced by the excellence of the linework produced; the making of corrections and

changes was simplified; it allowed for the new concept of 1:1 production which saved untold man-hours; and it was much easier to train personnel and allowed the Division to lower somewhat its recruitment standards and procure draftsmen who would not have been able to achieve the more difficult ink drafting level of competence.

One disadvantage in the new mechanical scribing approach to thematic mapping was the elimination of a certain natural visual character of coastlines and drainage which could only be achieved by ink drafting. This loss, however, was recognized only by the cartographers and had no apparent effect on the map users.

b. The Introduction of Reproduction Support Facilities

The need for some sort of in-house reproduction facilities was felt by the Cartography Division as early as the mid-1950's because of the timelag in obtaining preliminary support through the normal reproduction plant channels. This need intensified as cartographic techniques expanded and as the requirement to support current intelligence demands increased and deadlines narrowed. As Division production mounted, so did the need for

preliminary reproduction support from the reproduction plant. There were requirements by compilation for composite film positives on which to compile new substantive thematic data. There was also a need by compilation for reduction or enlargement of source materials to bring them to compilation scale. Shaded relief work required the processing of bluelines. The Drafting Section required film positives of scribed negatives and the processing of Peel Coats to produce tone drawings. Current intelligence required immediate response for film positives on which to produce new graphics and the processing of 3M Color Keys to produce vugraph slides. The variety grew yearly, but the understanding for the need lessened on the part of the reproduction plant, which began to develop an unsympathetic attitude. The reason was that the "minor" requests by the Division, no matter how critical, cut into the normal processing procedures of final reproduction work. The Cartography Division tried in vain to persuade the Printing Services Division to establish a small separate unit to handle these intermediate phases of map production in order to ease the disruption at the Plant and to give the cartographers the service they felt they required.

The idea of establishing reproduction facilities in the Division was supported by all production personnel of the Division but was opposed by one key individual. Mr. [redacted] (b)(3) (b)(6) [redacted] who had moved up to the position of Deputy (b)(3) (b)(6) Division Chief, felt strongly that the Division should not attempt to impinge on Printing Services Division's responsibilities and that all efforts should be put into convincing PSD to make the necessary adjustments to support the Division. Nevertheless, the Lab was directed by Mr. [redacted] who replac(b)(3) (b)(6) Mr. [redacted] as Chief of the Development and Construction (b)(3) (b)(6) Branch, to keep the problem in mind and its eyes and ears open for possible solutions.

On his 1958 trip to ACIC, Mr. [redacted] observed (b)(3) (b)(6) development which was watched closely for the next two years. Mr. Sovar of the ACIC Cartographic Lab had developed the predecessor to the K&E Helio scribecoat. He had taken regular, unsensitized scribecoat and hand applied a diazo coating. His overall idea, however, included a simple "black box" with ultraviolet fluorescent tubes which could be operated by the draftsman to produce his own scribing image from the manuscript rather than process the request through the ACIC reproduction plant.

The problem was similar to the one the Division faced. Mr. Sovar's black box was only in the drawing stage in 1958, but two years later he had several in operation.

In 1960 the Direct Reproduction Corporation introduced a daylight handled material called Striprite used to create tone drawings mechanically. Until this time, all tonal areas were produced by outlining the area with a fine ink line then filling the area by brush with a turpentine opaque or by the use of Rubylith, a mylar base material with a coating that could be removed after cutting. These processes were tedious and time consuming but were commonly accepted as the only methods to perform the operation.

Striprite was developed to be used in direct association with scribing. If an open-water tone area was desired, for example, the draftsman would scribe only the coastline portion of the drainage. He would then make or have made a film positive. The positive would in turn be exposed to Striprite by a short ultraviolet light exposure. Two simple develop-and-etch steps produced a duplicate of the original scribed negative. At this point, the draftsman literally picked up the portion of the Striprite he did not require. The coating was easily peeled off

the vinyl base by a sharp knife, thereby leaving a perfectly registered, completed tone drawing. The implication was enormous.

Also in 1960 K&E introduced its Helio scribecoat which required an ultraviolet light exposure as the first step in a two-step process. The introduction of this material would greatly enhance the scribing operation.

At about the same time, the Eugene Dietzgen Company began selling VanDyke film. This film was produced on a mylar base for stability and was exposed through a negative by an ultraviolet light source and simply developed in running water. Lab tests of the processed material determined that VanDyke positives were suitable for exposure to Striprite and could also be used as intermediate positives for processing new work.

The above three processes could have added another dimension of production capability to the Cartography Division, but not without the missing key, the ultraviolet light source. (b)(3) (b)(6) [redacted] and Mr. [redacted] endeavored to convince Mr. Sachs at the (b)(3) (b)(6) 1960 ACSM Convention, where his company was exhibiting its products, that the Direct Reproduction Corporation should manu-

facture and market a black box similar to the one Mr. Sovar had added to the ACIC production operation. The Direct Repro Box could be sold primarily to small organizations with the same production problems that faced the Cartography Division. Mr. Sachs took up the idea, and the exposure unit was ready for demonstration and sale in the fall of 1960. The next step was to convince Mr. [redacted] that the purchase of a black box for (b)(3) (b)(6) Division was imperative to maintain technical growth and expansion.

A demonstration of the Direct Repro Box, which involved the processing of several of the company's materials, was set up at the company's recently opened Falls Church, Virginia, office. Mr. [redacted] Chief of the Cartography Divi (b)(3) (b)(6) was invited to attend, in addition to Mr. [redacted]. The de (b)(3) (b)(6) stration went off beautifully with the new U. V. exposure unit performing flawlessly. Striprites were processed and peeled; dye proofs, using another company product, were made; and diazo images were exposed and developed. The advantages of the Division installing such a system were manifest, and Mr. [redacted] (b)(3) (b)(6) approved the "go-ahead".

Mr. [redacted] resistance was finally overcome, and the black box exposure unit was installed in the Lab early in 1961. The unit was constructed of wood and contained a battery of ultraviolet fluorescent lamps. Material to be exposed was placed on a clear-glass surface which covered the lamps, and a heavy sponge-covered hinged lid was pulled down onto the material and latched for pressure. A side-mounted timer controlled the length of exposure. The Helio scribecoat system was put into operation immediately. Stripríte (Figure 8) was purchased, and it too was made standard stock after a procedure was established for its use and personnel were trained. Dietzgen VanDyke film also became a standard item. Furthermore, shortly after installation of the new unit, the Terrain Section began preparing its bluelines via the black box and obtaining better control than had been available through the regular reproduction system. (b)(3) (b)(6)

The installation of the black box, even in this relatively primitive state, created a sudden feeling of pride throughout the Division, which was no longer totally dependent on another component to support its activities. The draftsmen, who were closest to the development, quickly accepted the new

procedures. Not only was the time it took them to process a map through Drafting further reduced, but their involvement in performing the new support operations also made their jobs more responsible and hence more interesting and challenging.

(b)(3)
(b)(6)

The system remained relatively unchanged until the early days of th[redacted]ra when demands on the system began to outweigh its capabilities, and a major expansion of the facilities took place.

c. Pencil Compilation Techniques

Thematic map compilation did not witness the revolutionary changes over the years that the construction side did. Most of the changes that occurred were made to accommodate technical advances in map construction. During the 1940's and for most of the 1950's, compilers used Dr. Martin's and Artone colored inks to prepare compilation manuscripts. The procedure had become so ingrained that no one suggested an alternate method even though several compilers had a difficult time achieving acceptable quality ink linework. Relatively more time went into the techniques of preparing an esthetically acceptable manuscript than into the substantive accuracy of the project. This is not to

imply that substantive accuracy was ignored but rather that mechanical techniques took too much time. Around 1958, when scribing made its impact, the inked manuscripts became increasingly difficult to use. Compilers were compelled to put tighter detail on their manuscripts for the 1:1 concept, and the draftsmen were finding this detail diffused and difficult to follow when scribing through the scribe coating. Tests were made in the Lab involving transfer of the inked lines to the scribecoat using the ACIC pre-Helio scribecoat method, but the light burned through the transparent ink lines and a poor image resulted. The Lab then recommended that a thorough study be made of switching from pen-and-ink to pencils for all compilation. Most compilers were enthusiastic about the possible changeover. (b)(3) (b)(6)

Mr. [redacted] spent many days searching out all the makes and varieties of colored pencils he could purchase at local art supply and stationary dealers. Systematic series of tests were devised for hardness, durability, ease of sharpening, and opacity, and every color of every make was put through the experimentation. The tests showed that Eagle Verithin colored pencils gave the best all-around performance, and they were recommended for immediate use. Also recommended to accom-

pany the new system were electric pencil sharpeners, located at strategic positions within the compilation area, to save hand sharpening time.

After several production tests the system was adopted as standard operating procedure. The results were gratifying to all concerned. The compiler was completely relieved of his unwarranted efforts to produce quality linework by the difficult to use pen-and-ink method, and his rate of output increased perceptibly. The draftsman received a much finer, denser line to follow, which made his job easier and required fewer follow-up corrections.

With the introduction of Helio scribecoat in 1961, the Eagle Verithins proved excellent in diazo line transfer. However, a new hierarchy of colors had to be established because of the range of opacity of different colors (Figure 9). Normally, blue was used to compile coastlines and drainage, but blue made a relatively poor diazo line transfer (this proved true in all varieties of pencils). Because coastlines and drainage were prime elements, it was mandatory that they appear solid and sharp on the scribecoat for ease of scribing. Therefore, green was selected as an appropriate color to use. This color selection

procedure was followed for the other elements which made up the manuscript worksheet, according to their relative importance. For example, yellow was highly recommended for boundaries because of its transferability, whereas prior to this time yellow would have been outlawed for such an important role.

Several reexaminations were made over the next ten years as new pencils were introduced, but Eagle Verithin always proved to be the best.

In 1963, a similar study was made with ballpoint pens in an effort to further reduce the compilers' problems in preparing a manuscript. Even though diazo transfer was not quite as high in quality as with the Eagle Verithins, a set of ballpoint pens -- a combination of BIC and Lindy -- was recommended for use. Ballpoint compilation became the rage for a short time, but gradually almost all compilers returned to colored pencils. They discovered that, with continuous use of the pens, the ink blobbed at the point and left smudges if not cleaned repeatedly. When this occurred, maintaining a consistent line became difficult, and the manuscript took on a less professional appearance.

d. Revamping the Symbol Files

Division symbol holdings steadily increased after the 1952 reorganization of the files and the issuance of the Symbol Guide. As new problems arose, new symbols were designed and added, and, as expedients, intermediate sizes were produced from available symbols to satisfy special requests. Symbols were available in a wide variety of abstract and pictorial forms and sizes. They were also available in a selection of contrasting colors. As a result, they were widely used throughout the Agency as an aid in graphically communicating a broad range of subjects. For example, an analyst wishing to portray quickly the disposition of forces along a country border could easily apply the appropriate number of large red triangles to a copy of a printed map obtained from the library in a very few minutes. So many outside-the-Division customers were serviced that the Cartography Division became better known as the "Symbol Division" by many Agency personnel. By 1958 the file had again become unmanageable, and the Lab was again directed to put it in order. A significant upgrading of standards had occurred during the intervening six-year period, and it was found on close examination that the early symbol quality left much to be desired compared to the current quality. After

careful consideration, it was decided to reissue the old symbols at current standards and to update the complete system. Mr. [redacted] who had just become the second Lab man, (b)(3) (b)(6)
was assigned this task in 1958-59. The massive undertaking involved redrawing most of the original symbols developed during OSS days and then progressing through the various reductions to achieve the full range of sizes. Several hundred new panels were produced, which were in turn contracted to the US Government Printing Office (GPO) for processing. At GPO the panels were converted to photo engravings on 0.0152" zinc. On their return to the Division, the engravings were microscopically examined for quality, then routed to the Type Section for printing. After printing the copy was again examined for quality before being filed. At this point in the procedure the Branch was fully confident that any symbol which had progressed to this stage was well within the quality standards which had been established.

In conjunction with the remaking of the symbols themselves, a new filing system was put into operation. The system was designed for easy access by the draftsman and also to make filing copy and reviewing the supply much simpler than under the former system. Accompanying the file was a wing-panel display board which exhibited every size of every symbol on file.

In addition, a master catalog was produced which became the "Bible" on symbols. This was kept up-to-date and represented the complete catalog of symbol holdings. To complete the operation, a duplicate of the original master catalog was prepared, and one full sheet of every symbol was collected for the Cartography Division's Vital Storage Area.

Toward the end of this reporting period it was recognized that another major updating of the symbol files was urgently needed. Very little new symbol work had been accomplished since the 1958-59 revamping. New concepts in thematic mapping had outmoded many of the old symbols, and new representations, both abstract and pictorial, were sorely lacking. However, the chance to repeat the 1958-59 renovation seemed very unlikely because of inadequate manpower.

e. Type Placement Guide

There was an unwritten understanding throughout the entire history of the Cartography Division that the draftsman had the final responsibility for type placement. By virtue of performing this operation repeatedly he was supposed to have the most experience and the best judgment in properly positioning

the toponymy of a map in an unambiguous and esthetically pleasing manner. This supposition was not entirely true, for new draftsmen were expected to have the same ability as those with many years of experience. Furthermore, the basic principles of type placement, although covered thoroughly in the Division training program, were often misunderstood by new and old draftsmen alike. The problem lay in the fact that there were no written guidelines which clearly and precisely stated the principles of good type placement.

The problem came to a head around 1960 when the Division was developing a high degree of sophistication in its approach to thematic map production. Conflicts arose over the question, "What is good type placement?" New ad hoc principles were created to press a point, and eventually the problem became critical. The Development and Construction Branch, in an effort to alleviate the confusion, recommended the production of a Division Type Placement Guide which would present in words and graphics the type placement principles to be practiced in the Division. The recommendation was approved, and the Lab was assigned the project.

Mr. [redacted] began a thorough investigation into (b)(3) (b)(6) the type placement practices and came up with several guide samples produced by other agencies. They all told "how" but not "why", so the Division's guide had to be developed from bottom up.

Hundreds of Division maps were carefully studied, and the major areas of concern were isolated. Each of these was developed to show the wrong way as well as the right way to place a particular name. In several cases, full-color renditions had to be produced to demonstrate color overprint problems. Overall, a highly scientific approach was taken toward the problem. Production of the Guide, with its numerous illustrations, took over a year and a half on a time-available basis. It required many roughs, many consultations with draftsmen and compilers, and many discussions with cartographers outside the Division. The final Guide was a monumental achievement and was the first and only publication of its kind produced by the Division.

The Type Placement Guide did much to formalize type placement procedures in the Division. Compilers felt more assured that agreed principles were being followed, and all drafts-

men had the same handy reference which ruled on clearing up problem areas.

5. Other Accomplishments During This Period

Many relatively minor developments were introduced during the [redacted] Era which, when totalled, added to the overall (b)(3) (b)(6) efficiency of the compilation and construction processes of thematic mapping. They are, however, too numerous to discuss in detail in this report.* Six developments are, nevertheless, worthy of mention.

a. Accent Sheets

The production of maps of foreign countries involved the use, for the most part, of US Board on Geographic Names recommendations for place-name spellings. For many countries this meant the additional requirement to include diacritical marks to indicate pronunciation -- a major problem for the draftsman who, in many instances, spent as much time adding diacritics by hand as it took to position the names. On

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* Details of these developments can be found in the Record Center Archival Files, OBGI, Cartography Division, Item 71-437.

some countries this became a serious handicap but one that could not be ignored or avoided.

At relatively great expense, accented letters were produced by American Type Founders of Elizabeth, New Jersey, for 8 and 10 point News Gothic, the style and sizes most commonly used for city names. This was of some help in easing the pressure, but it did not eliminate the problem because the cost to expand accents to other styles and sizes was prohibitive.

To solve this problem, the Lab in 1954 began the production of "accent sheets", as they were called in the Division. Preliminary study showed that the Division's type holdings could be divided into two family groups, serif and sans-serif, with each subdivided into light and heavy. Consequently, four sheets were planned. Thorough investigation went into the design of each diacritical mark, and large masters were produced following the scheme used for the production of symbols. Each sheet carried a range of sizes from 6 pt. to 24 pt. The four original panels were then converted to photo engravings, printed on standard celanese, and filed. Extreme quality control was followed during the entire process, and the

completed sheets exactly matched the printed type on which they were to be placed (Figure 10).

The production of these accent sheets eliminated the slow hand-drafting formerly required and brought about a uniformity of end product never before achieved.

b. Plastic Cutting Table

The introduction of plastic as a compilation and drafting base brought about a major change in the production process (II, A, 5, b), but it created a new problem -- that of cutting the material. Dyrite was stable and durable but, when cut with scissors, it shattered, leaving a jagged and dangerous edge. Many alternative methods were tried but the one that proved best, cutting against a steel straightedge, was the most time consuming.

At about this time an advertisement for the Metoschmit cutter, designed to cut plastics, was noted in a German publication received from the US Geographic Attache. The basic principle of the cutter involved a circular cutting knife which rode along a steel edge. The cutter seemed to be the solution to the problem, but because of its foreign manu-

facture and a "Buy American" attitude that was prevalent at the time, it was very difficult to arrange a purchase. Persistence paid off, however, and the cutter finally arrived from Germany in late 1954.

Although very simple in construction, its quality was extremely high, and it cut Dyrite with a felt-smooth edge. A table was designed and built incorporating the cutter into one end, and another production problem was solved. (The cutter is still being used today, cutting the various plastics now in stock as effectively as it did in 1954.)

c. Craftsman Line-up Table

The relatively simple task of laying out a "square" map (all four corners exactly 90°) often became a problem for compilers and draftsmen when a very large map was in process or if extreme care was not exercised in handling the triangles and straightedges. Considerable time was wasted, many times at the final stages of a job, adjusting the neatlines and borders of a map when it was recognized that the original manuscript had not been squared and the draftsman had not checked it before drafting.

In 1957 the Lab recommended the purchase of a Craftsman Line-up Table, a precision instrument for squaring drawings. Although designed primarily for the lithographic industry, it would work equally as well for cartography. The recommendation to spend the $2,000 was approved, and the piece of equipment was purchased and installed. From that time on layout ceased to be a problem. The compiler used the table to construct his manuscript outline, and the draftsman followed up by using the table to ink or scribe the neatlines and borders.

The Craftsman Line-up Table was equipped with an automatic spacing mechanism which also enabled the operator to create grids of extreme accuracy. Special grids, many very tightly spaced, which would have required weeks to produce by hand, were constructed in a matter of hours by using the machine.

d. Japanese Penpoint

Penpoints for freehand fine-line inking were taken for granted. The use of the Hunt 102 and 104 and the Esterbrook 356 had been established in the 1940's, and no

thought was ever given to replacing them because they always produced excellently. In 1959, however, among cartographic items received from the Far East Geographic Attache was a sample card of penpoints produced by the Japanese firm, Toyo Seiko Co., Ltd. of Tokyo. The Lab tested them as a matter of course and to its amazement found one to be superior to any penpoint then in use. It was the Nikko 659. Further tests proved the point to be easier to use, more durable, and more consistent in line weight and quality than the stock penpoints.

A dispatch to the Geographic Attache to purchase a supply produced a response that the penpoints could only be purchased by the 100 gross lot. With scribing imminent and the anticipated declining use of pen and ink in the offing, this amount would have been overwhelming. Luckily the Attache was able to convince the company to sell him 25 gross, enough to last the Division for many years.

The Nikko 659 soon became the basic penpoint for all fine-line drafting, increasing quality and easing drafting training as it did so.

e. Rubylith

The preparation of tone drawings by the pen-and-ink/opaque method was very tedious and time-consuming. By this method, the draftsman was forced to first outline the area with a fine ink line, then fill in with a turpentine opaque solution by sable brush. The more intricate the details of the area to be toned, the greater the increase in time it took to perform the operation.

A new material produced by the Ulano Company, called Rubylith, was observed at a 1959 Lithographic Trade Fair. The material had been developed and introduced for use in the photo lithographic industry to prepare negative masks. Rubylith consisted of a clear mylar base with a ruby red cuttable coating. When cut through to the base, the coating could be easily removed. It was recognized immediately as a feasible substitute for hand-drafted tone drawings. Tests proved successful, and Rubylith quickly became a standard material for drafting use. Rubylith did not fully replace the hand-drafted drawings, however. It was still found to be more efficient and practical to use the pen-and-ink/opaque method on very small areas where the use of Rubylith became too frustrating for the draftsman.

Later, the Ulano Company introduced Amberlith, which was the same as Rubylith except that it was amber in color. Amberlith then became the standard because the lighter color was much easier to use over colored manuscripts. Again, in the case of the Rubylith and Amberlith, a saving of considerable production time was realized, further reducing the length of time it took to produce a map.

f. <u>Conversion of Drafting Tables to Light Tables</u>

The disappointing failure of electroluminescence in 1958 (II, B, 6) spurred an effort to replace the bulky light tables which were difficult to work against and space consuming. A portable light box, Porta-trace, marketed by the Ozalid Company, had been purchased for general Division use but was usually kept in the Lab on one of the Stacormatic drafting tables. In early 1961, while working on the box-on-table combination, Mr. [redacted] had the idea of incorporating the Porta-trace un(b)(3) (b)(6) into the drawing table top and converting it to a light table. Plans were drawn, a piece of sandblasted plate glass was purchased, and the first unit was converted for the Division by the Department of State's Carpenter Shop. The converted table

was an immediate success, especially to the research compilers and the Special Support Branch cartographers. The decision was then made to convert all drafting tables, and a total of 35 were eventually processed.

As a direct result, several large light tables were disposed of, and the Division was afforded a better and more efficient use of floor space in the new Headquarters Building. (The Drafting Section was not affected by this changeover, and the draftsmen continued to work over the cumbersome tables until 1971 when a more suitable table was found for the draftsmen.)

6. <u>Electroluminescence: A Memorable Failure</u>

Although the experiment with electroluminescence failed, through no fault of the Cartographic Lab, it is worth describing because of the nature of the problem and the implications which it carried.

Working over and through translucent compilation and drafting materials required the use of light tables in the Cartography Division. These tables were large, bulky tubs which contained batteries of fluorescent lamps and were sur-

faced with sandblasted plate glass. They occupied considerable space, they were difficult to work against, and they were dangerous when the glass tops were accidentally broken. On one occasion, a draftsman working on a large job actually fell through one of the large tables and narrowly missed serious injury. Replacing the tables was for years a hopeful wish, but there was no suitable substitute.

In 1956 the Lamp Division of the Westinghouse Corporation announced experiments with a new light source -- electroluminescence. The announcement described a flat surface lamp, only slightly thicker than window glass, consuming little power, and generating practically no heat. The advantages of such a light source were immediately recognized in the Cartography Division. This flat piece of glass which would transform any flat surface into a "light table" would effect a tremendous saving in space as well as provide a more comfortable working area for the cartographer or draftsman.

Westinghouse was contacted in February 1957, and representatives of the Division were invited to attend a demonstration of "Rayescent Lamps", Westinghouse's trade name for its new light source. It was explained that the generation of

light by the phenomenon of electroluminescence was entirely different from conventional methods. There were no heated filaments, gas filled tubes, or metallic vapors. Instead, a thin layer of phosphor was sandwiched between two conductive plates; one made of a specially coated glass and the other of metal. When an alternating current was applied to the conductor plates, the phosphors were excited by the current and light was produced, the color of the light emitted depending upon the phosphor used. At the time of the demonstration, Westinghouse had developed a green lamp which operated at 600 volts and a frequency of 3000 cycles per second. The low-level illumination produced was unsuitable for cartographic use, but the Westinghouse engineers were confident that they would soon significantly increase the brilliance.

By the fall of 1957 progress had been made to the point where a new panel, operating at 600 V and 60 cps, gave the same illumination as the earlier panel at 3,000 cps. Several 1-foot-square panels to operate at 230V were purchased by the Lab at that time to demonstrate the principle, but because of the unavailability of suitable power equipment, no practical experiments were conducted.

Through a regular contact with Mr. Lionel Moore of the USGS Cartographic Lab, the Division learned that they were also experimenting with Rayescent panels and had been deeply involved with their Electronics Section in developing power equipment. It turned out that USGS was much further advanced in their development of the system than was Westinghouse, and they offered to supply the Agency with 18" x 24" lamps and powerpacks to operate at 600V and 60 cps, their recommendation for maximum efficiency. Five large lamps with powerpacks were ordered for Division experimentation. In addition, two 12" x 12" panels with powerpacks designed to transform European current (230 V, 5 cps) to 600 V, 400 cps were ordered, and one was eventually sent to the Geographic Attache in Europe for demonstration purposes.

In October 1958, Rayescent lamps and powerpacks were put into use in all Branches of the Division on an experimental/production basis. The lamps did not meet with immediate approval from the compilers who needed a brighter light over which to compile, and the panels were returned to the Lab for powerpack modification to increase the frequency. The Drafting Section and the Special Support Branch, however,

reported the lamps to be very satisfactory, though they too would have welcomed a brighter light. The lamps were in operation eight hours a day for more than three months, and future prospects seemed very encouraging. Plans were already being made to eliminate all light tables in the Division's area in the new Headquarters Building.

Just as the new system looked most promising, one of the units developed a short circuit which exploded the panel and sent glass chips flying. Most fortunately the cartographer was at lunch, and no injury was sustained. Of course, the experiment was immediately shelved pending an investigation into the cause of the malfunction. The cause was never discovered, the system never became operational, and Westinghouse never marketed Rayescent.

7. The Era Ends

In April 1962, Mr. [redacted] was offered an opportunity (b)(3) (b)(6) for advancement and transferred to NPIC, leaving the Cartographic Lab virtually inactive for over a year. His tenure had been an outstanding period of research and development for the Cartography Division, which saw major changes in

operating procedures, an enormous increase in production, and a marked upgrading of quality.

C. The [redacted] Era: A Period of Renewed Activity (1963-1964) (b)(3) (b)(6)

1. Mr. [redacted] Takes Over Lab on Transfer From the Army Map Service (b)(3) (b)(6)

After Mr. [redacted] departure, a thorough search of (b)(3) (b)(6) Division personnel was made to find a replacement for the Lab. No candidate was found, so the search turned outward. Informal contacts were made with other mapping agencies to inform them of the vacancy. Three cartographers applied for the position and after a series of interviews, Mr. [redacted] (b)(3) (b)(6) of the Army Map Service (AMS) was selected. He reported for duty in April 1963.

Mr. [redacted] had been with AMS for more than 20 (b)(3) (b)(6) years and had a thorough background in topographic mapping techniques and procedures. It took him a few months to become familiar with thematic mapping procedures as they were handled by the Cartography Division, especially the informality of operation.

His first order of business was to re-establish contacts with the various local mapping organizations and the second, to

prepare an updated program for the Lab. These he accomplished without delay. The Lab program covered the identical points that were established in 1954 (II, B, 2) but with major emphasis on streamlining and increasing the efficiency of the construction operation. Mr. [redacted] approached the challe (b)(3) (b)(6) with the disadvantage of not having had much previous experience in thematic mapping.

2. Significant Accomplishments of This Period

a. Expansion of Reproduction Support Facilities

The Lab area, having been designated the location of the UV Black Box exposure unit, became the center of activity for reproduction support work. Scribing was expanding rapidly, which meant that the processing of Helio scribecoats increased correspondingly. Contacts with commercial salesmen gave some indications that new daylight handled materials were being developed which would eventually benefit the Division. Meanwhile, quality standards were rising, and it was felt that the black box and "pickle jar" systems had reached their limits. In the fall of 1963, Mr. [redacted] began a study to determine (b)(3) (b)(6) requirements for upgrading the Division's facilities to support

the anticipated buildup in reproduction work. His recommendation included the adoption of three basic elements: 1) the Ozalid Streamliner 100, a 30" diazo processor; 2) the 30" x 40" nuArc Flip-Top Platemaker, with vacuum frame and carbon arc light source; and 3) the 6' Leedal processing sink. These three basic units would support a variety of operations in a minimum of space. The recommendations were approved, and the items were purchased and installed by mid-1964. This complete unit gave the Division a new dimension of support and allowed its cartographers and draftsmen to become more self-reliant and less dependent on the reproduction plant.

The Ozalid machine allowed for the in-house production of Vugraph slides and enabled the Division to respond more rapidly to support top-level briefings. The Ozalid was also used to prepare quick diazo proofs directly from original drawings, a luxury never before experienced. The contact printer not only exposed Striprite and Helio scribecoats, which were processed through the developing chamber of the Ozalid, but also became the focal point for the exposure of Wash-Off film and Duplication Scribecoat which will be discussed later.

An interesting sidelight developed while Division representatives were working with the nuArc salesman. The nuArc Flip-Top Platemaker was purely a piece of lithographic reproduction equipment, as were the Ozalid and the processing sink, and as such they had to be approved for purchase by the Printing Services Division (PSD). There was some concern in the Cartography Division that PSD would not give this approval because they might not fully understand the use to which these items would be put in cartographic production. To counter this possibility, the nuArc Company was ready to prepare a new name plate for its printer, calling it the Cartographic Flip-Top Printer. Fortunately, an advanced reading from PSD proved the feeling was unjustified. Approval was given, and the printer was not renamed.

b. Kodak Kodagraph Wash-Off Film

In late 1963, the Eastman Kodak Company introduced a new film which was to cause major repercussions in the Cartography Division. This new film, Kodagraph Wash-Off, was daylight handled and therefore did not require a darkroom for processing. In fact, processing was so simple

the first announcements were thought to be in error. The film required a ten-second exposure in the vacuum printer, one minute's submersion in an activator, then was washed in warm water and dried -- all this in ordinary room light. Moreover, the film was on Estar, the most stable of Kodak's bases. The material seemed ideal for Division use, and a roll of the film was ordered. Tests proved beyond a doubt that Kodagraph Wash-Off film should be added to the processes available for Division use. The resultant wash-off positives (Figure 11) were of extremely high quality -- equal to any processed by PSD. As a result, Dietzgen VanDyke film was dropped.

The addition of Wash-Off film made an immediate difference in the Division's operations. The Special Support Branch was able to produce positives from available negatives in a matter of minutes in response to urgent current intelligence requests. The Drafting Section made its own positives from scribecoats, thus eliminating the long delays encountered when these were processed via PSD. Job scheduling became easier, and calendar time to produce an average job was cut significantly. The Terrain Section processed its own bluelines

by means of a Wash-Off negative, also eliminating production delays. Composite Wash-Off positives, made by multiple exposures, were used for editing scribed drawings. In other words, the material was so versatile and its processing was so simple that Kodagraph Wash-Off film found its way into every phase of production. By the end of this reporting period the Division was using 10,000 sheets of this film a year.

c. Cronaflex Film for Compilation

Other than switching from ink to pencils there had been no change in manuscript preparation since Dyrite was introduced in the early 1950's. Even though a high quality pencil image was being produced on Dyrite, its grain, which was ideal for final drafting, rapidly wore down finely sharpened colored pencils, thereby requiring the compiler to spend an inordinate amount of time sharpening pencils. A better compilation base had therefore been on the Lab's "most wanted" list for many years. In 1964, the Dupont Corporation added Cronaflex U/C to its line of Cronaflex films. This new material was stable because of its mylar base and contained a very fine chemically produced grain. It proved to be the ideal

replacement for Dyrite. Not only did the Cronaflex U/C surface allow the compiler longer periods of time between pencil sharpenings, but it also produced more brilliant lines, enabling the draftsman to perceive them more readily. The Cronaflex U/C manuscript image also made a higher quality diazo transfer to the Helio Scribecoat, its finer grain being less diffusing.

d. Experimentation with Silk Screening

In the late 1950's and early 1960's, an increasing demand was put on the Division to provide supporting maps in very small quantity for special intelligence reports -- three to five copies being the usual requirement. Producing the maps, which involved the overprinting of existing Agency, Army, or Air Force maps, was a routine matter, but obtaining the few copies became a problem. These requests were almost always accompanied by extremely short deadlines, and the decision whether to produce hand copies or to have PSD overprint the existing maps had to be made on the basis of the manpower situation in both Divisions at the time. A possible solution was to employ the silk screen

process, which seemed to lend itself to this type of low-run requirement.

Mr. [redacted] began a series of tests and exper- (b)(3) (b)(6) ments with equipment borrowed from the Office of Logistics Visual Aids Group. Again the nuArc printer became the focal point as the drafted originals were exposed to Ulano Hi-fi stencils which were water developed and then adhered to the silk screen. Transferring the image was accomplished in the usual manner of applying paint to the screen and squeegeeing the paint through the open areas of the screen onto the paper map. Two problems had to be solved, however: registering the overprint with the printed map and finding a transparent paint which would not obliterate the base map detail.

A simple adjustable rig was built onto which the printed map was taped. The silk screen frame was also secured to the rig, but adjustments were added to enable the operator to shift the screen in all directions without detaching it. A few quick transfer tests put the overprinted image in its exact position on the map.

Finding a transparent paint was more difficult because the so-called transparent silk screen paints purchased

locally proved to be more opaque than transparent. Finally, after numerous trials and errors, a truly transparent paint, Naz-dar Transparent Silk Screen paint, was purchased from a Baltimore, Maryland, supply house. The system was considered operational in mid-1964, but, unfortunately, at this precise time the requirements to produce this type of map support completely ceased. The system was never employed although it was kept in readiness for several years thereafter.

3. The Cartographic Lab Again Becomes Dormant

Mr. [redacted] decided in late 1964 that he was more (b)(3) (b)(6) production than research and development oriented, so he applied for the position of Chief of the Drafting Section which had been vacated. He was accepted and in November 1964 left the Lab to take over his new assignment.

D. Research and Development Continues Informally and Sporadically (1965-1970)

1. An Intensive Search for a Lab Man Is Fruitless But Research and Development Do Not Stop

A repeat of the exercise of 1962, when Mr. [redacted] (b)(3) (b)(6) departed the Division, began. Division personnel were canvassed, and the word was informally passed to the major mapping organi-

zations, but to no avail. No one could be found who had the depth of training and experience and the strong desire to perform research and development work that were required. The search actually continued for several years until Division management decided in 1968, with the reluctant concurrence of the Branch Chief, to eliminate the Cartographic Lab slot and transfer it to the newly developing Automation Section of the Branch.

Eliminating the Lab position in no way eliminated the need for research and development. The Division had become too accustomed, over the previous 17 years, to being on top of thematic cartographic techniques for this situation to suddenly come to an end. It was decided, within the Branch, that the Technical Support Branch management would make itself responsible for keeping abreast of developments in the field. Although it was informal, a program developed whereby key Branch personnel became deliberately involved in R&D. This involvement took the form of out-of-town survey trips, local visits, and attendance at professional meetings. Only developments of a relatively major nature received follow-up R&D work in the Branch and these only by special assignment.

Local contacts were maintained by telephone, and visits were made when developments warranted. Several out-of-town survey trips were made which included foreign (b)(3) (b)(6) and domestic organizations. In the Spring of 1967, Mr. [redacted] Chief of the Branch, attended the [redacted] (b)(1) (b)(3) [redacted] During 1968, Mr. [redacted] Deputy Branch Chief, (b)(3) (b)(6) surveyed US mapping programs and visited eight organizations from coast-to-coast and Mr. [redacted] visited three organiza- (b)(3) (b)(6) tions east of the Mississippi. In 1969, Mr. [redacted] Chief of (b)(3) (b)(6) the Special Projects Section, visited five mapping and advertising organizations in the New York area, and the following year, 1970, Mr. [redacted] Chief of the Cartographic Constr (b)(3) (b)(6) tion Section, visited four organizations in the east and mid-west. All VCC and ACSM conventions were also attended.

During this period R&D was handled on an unavoidably haphazard basis. Reluctantly, most ideas picked up as a result of the above visits were recorded without follow-up because of lack of manpower, but developments and trends were at least known. Division management was always well aware of the con-

flict between R&D and production although, because of the critical nature of demands on the Division during this period, decisions almost always leaned toward carrying on production. There were, however, four significant developments which could not be overlooked, and time was found to investigate and introduce them into the overall system.

2. Significant Accomplishments During This Period

a. Duplication Scribecoat

From the earliest days of the Division's history, one particular problem arose repeatedly -- that of compiling and drafting exact duplicate images. For example, if a page layout included several small insets of a country, each to present a different theme, the basic country outlines, coastline, drainage, and boundaries were expected to be exactly the same in every detail, even though the thematic data varied. No matter how carefully the compiler produced his manuscript and how painstakingly the draftsman followed his lines, the final printed maps always showed variances. The problem was solved in 1966 when Keuffel & Esser developed Duplication Scribecoat.

Duplication Scribecoat was a mylar base material with a diazo sensitized scribing coating. Exposure onto the material was made in the nuArc vacuum frame through a regular scribed negative, such as Helio scribecoat. The exposed material was then passed through the developing chamber of the Ozalid machine. The result was a duplicate negative. Multiple exposures of the scribed negative would result in multiple duplicates on the Duplication Scribecoat (Figure 12). The multiple exposures could be preplanned for position, and a step-and-repeat process could produce any number of images, all exactly the same.

The new material was first observed at the 1966 ACSM Convention. Samples were procured, and Mr. [redacted] (b)(3) (b)(6) a draftsman who later became Chief of the Automation Section, was assigned to perform a series of tests and production experiments. He developed a procedure which involved an interplay between the compiler and draftsman.

In this new procedure, the compiler prepared a layout showing precisely where he wanted the images duplicated and then compiled a single line manuscript of the map base. This set was, in turn, given to the draftsman who scribed the

map image only one time. He exposed the scribed negative in the positions determined by the compiler using the Duplication Scribecoat. The processed negative was then transferred to Kodagraph Wash-Off film. This produced a positive which contained the proper number of identical images in their exact positions. This positive was then returned to the compiler who, on a piece of Cronaflex U/C, completed his manuscript. In the final drafting stage the multiple image positive became the original drawing. Here again, not only was an efficient procedure evolved that saved both compilation and drafting manpower, but in addition the printed copy reflected a more professional approach.

b. Slot Register System

The punch (hole) register system devised in the late 1940's remained unchanged until 1967. Until the early 1960's, Dyrite plastic served as the compilation and drafting base, and drafting was still primarily a hand-inking operation. As new techniques developed and new materials were added to the construction process, problems began to arise concerning registration -- things were not registering as they should. It

became apparent that the cause was the intermixing of base materials -- vinyl, polystyrene, and mylar -- each with its own coefficient of expansion and contraction. The variances were enough, at their extremes, to throw the materials out of register, and the two registration holes, being stationary, caused buckling when this occurred.

The ACIC in St. Louis had under development at this time a new system of registration based on the radiating slot theory. The principle involved three oval slots, (1/4" x 1/2"), one at the top and one each left and right, all radiating from the center of the sheet. Round or oval register pins were inserted in the slots, and other drawings, similarly slotted, were placed in position on the pins. Even though the pins moved in the slots, the drawings were immovable with respect to one another. In this situation any minute change in size of the material was radiated uniformly in all directions, and the drawings always appeared to be in perfect registration. Differences could be microscopically calculated, but they were well within thematic mapping accuracy standards. The system was watched closely for more than a year after it became operational at ACIC.

In the early spring of 1967, Mr. [redacted] attended (b)(3) (b)(6) an "If-we-had-it-to-do-over-again" meeting at ACIC and noted the many modifications they recommended for a second-generation punch. Following that, several sheets of all materials used by the Division were slotted for production tests. The tests went well, and in April 1967 a slot-register punch which included most of the ACIC recommendations was ordered from the Moffett Precision Company, Batavia, Illinois. The system was installed in late 1967, and it revolutionized the handling of materials in the Division as well as solving existing registration problems (Figure 13).

All materials were prepunched before being distributed so that no compiler or draftsman had to concern himself with the task. It became the primary job of summer employees to punch thousands of sheets of materials to provide a supply which lasted throughout most of the year. Cutting of stock plastic had been eliminated years before when the Division limited its usage to four basic sizes which were purchased precut.* Combinations of standard size materials could be built up at will,

* Standard sheet sizes are 11" x 14", 17" x 21", 24" x 30", and 30" x 40".

beginning with the compiler's manuscript. Additional drawings added at any stage of the process caused no problem. Scribecoats for negative scribing could be flip-flopped and still register perfectly.

The system was expanded to include photographic film processed by PSD. The film was slot punched by the Cartography Division and stored at PSD. When a slotted positive was required, it was noted on the reproduction request. The returned positive then fit into the system and could be handled with other materials.

The slot register system, by eliminating registration problems and allowing for the prepunching of materials, saved at least 5 percent of the normal production time, thus increasing production capability.

c. <u>Hollow-tipped Scribing Cutters</u>

On his coast-to-coast survey trip in 1968, Mr. [redacted] discovered hollow-tipped scribing cutters at ACIC. (b)(3) (b)(6)
They had been developed to scribe heavy lines on the automatic plotter. Normal hand scribing of heavy lines was accomplished by the swivel graver and chisel cutters, and line weights of

0.024" and over were very difficult to handle. The new cutter, designed by Mr. Robert Sicking of ACIC, was rigid with a round hollow carbide tipped base. Mr. [redacted] tested the cutters, (b)(3) (b)(6) which had been inserted in regular rigid engravers, and found them extremely easy to use at line weights up to 0.045". Following detail was also much more accurate than with the swivel gravers. He immediately adapted these new cutters as replacements for the chisel cutters although ACIC had no plans to make this change.

The addition of the hollow-tipped cutters overcame the last bit of resistance in the Division toward scribing, allowing the full range of lines to be produced with relative ease.

d. Diatype Photocomposing Machine

The Type Section was established during OSS days, and, except for the addition of a new Vandercook 4T Proving Press in 1947 and an occasional replacement of worn foundry type, the unit's operation remained unchanged until 1970. This stagnation was not deliberate. As early as December 1955 statements regarding the search for a photocomposing machine to replace the handset type system began appearing in Branch

monthly reports. For several years in the early 1960's money was carried in the budget to cover the purchase of a photocomposing system. Many leads were followed, and many demonstrations were attended but no product matched the high quality and low cost desired. Photocomposing had already replaced hand type setting at the larger mapping agencies but the cost of these systems, Harris Intertype and Merganthaler Linofilm, was in the six-figure bracket. The Division wished to spend only $5,000.

Late in 1969, on a visit to New York in connection with the Division's consultant program, Mr. [redacted] was introduced to a new German photocomposing system by Mr. Aaron Burns, President of TypoGraphics, Inc. The system was Diatype. The machine was the size of a typewriter, produced extremely high quality 4 point through 38 point type from a single glass disc, had a superior lens system, exposed directly onto paper or film, and cost $5,000. A demonstration of the system, distributed in the United States by the Royal Zenith Corporation, New Hyde Park, New York, was later held in the Division, and all personnel were given a chance to view the machine in operation. The type was indeed top quality, matching any photo system regardless of cost.

(b)(3)
(b)(6)

Mr. [redacted] submitted a proposal for a comple (b)(3) (b)(6) Diatype system together with recommendations for phasing out handset type. In addition to the Diatype, the proposal recommended the purchase of an automatic film processor, a small nuArc vacuum printer with a pinpoint light source, and a Stat King camera (a self-contained camera unit which would be used to produce type over 38 point, the limit of the Diatype). Two prime reasons were given for converting from hand set to photocomposing: the average quality of Diatype far exceeded the highest quality of handset copy, and type output would double when the full system was in operation. Phase I of the plan was approved, and the first Diatype machine (Figure 14) was installed in April 1970. Sixteen discs representing 16 different type styles were included with the initial purchase. By the end of this reporting period the Diatype photocomposing machine and its makeshift darkroom in the Type Section had surpassed even the most optimistic expectations. In less than six months, more than half of all the type produced by the Section was done by the Diatype system. The outlook for proceeding to Phase II, the purchase of a film processor, looked bright for FY 72.

The Diatype system, even when fully implemented, will not eliminate the Vandercook Press. Although no type would be printed, the Division and the Agency still have need for the millions of individual symbols printed each year on the press.

3. Maintaining a Position of Technical Leadership Becomes Increasingly Difficult

By mid-1970, a new technical revolution was rampart in cartography. To maintain production levels, major mapping organizations were putting added efforts into research and development in order to offset the loss of personnel by reductions-in-force. Automation was flourishing. If there was ever a period when the Cartography Division needed a dynamic Cartographic Lab, it was then. But developments were moving the Technical Support Branch in an opposite direction which even precluded the Branch Staff's continuation of its minor involvement in R&D.

A Division reorganization in April 1970 had placed additional responsibilities on the Branch. The Automation Section was increased in size, and it siphoned off personnel from the Drafting Section. Impending new plotter and digitizing systems would most likely take away more draftsmen. The Special Projects Section was doubled in size with the assignment of new

blocks of work, and it required additional guidance and supervision. Additional Branch assignments which involved the Branch and Deputy Branch Chiefs further diluted any R&D effort.

Advances in the Division's automated cartography program alone warranted immediate R&D work to develop new technical procedures which would involve the interplay of compilers, draftsmen, and the computer-plotter. There was a growing fear among those closely involved in automation production and a strong possibility that the full potential of the system would not be realized because of this lack. By the end of 1970 much thought but very little effort was being applied to research and development work. The prospect of finding blocks of time, even for special R&D assignments, looked bleak for the future.

E. Ad hoc Procedures

Throughout its history, the Cartography Division was continually faced with demands which seemed impossible to meet because of the nature of the requests or the deadlines imposed. Time after time, however, these "impossible" requests were

fulfilled through the combined efforts of many inventive and resourceful Division personnel who improvised, took shortcuts, manipulated standard procedures, and developed ad hoc procedures to solve the problems. The Division's excellent reputation, in large part, was built on its ability to respond to these special requests. Division management, after accepting the requests, always turned the problems over to the production level administrators and allowed them to proceed with minimum interference and red tape. This policy was probably the primary reason for the success the Division enjoyed when confronted with such problems.

These challenges forced developments. Photo-drafting, a means of obtaining images by reducing or enlarging portions of available original or negative drawings and then splicing them into plastic, was devised in the early 1950's as an expedient to meet certain urgent requests. This procedure was presented by an industrial graphics specialist at the Visual Communications Congress in 1963 as a "new" method to obtain drawings without the normal redrafting or rescribing. The term "map-mechanic" was coined during this period, and it reflected, in many cases, a true description of the operation performed. Duties and responsibilities expanded and diversified to the point where, in

1970, the cartographic draftsman position was officially changed to cartographic technician, a position which covered a much broader range of cartographic production.

Any and all means were employed to satisfy map requests. Many times it was necessary to contact other mapping organizations which performed operations not available within the Agency. It would be impossible to list all the special jobs processed over the years in this ad hoc manner, but two projects are described to give an idea of the problems involved.

1. Khe Sanh Model

During the Khe Sanh crisis in Vietnam in 1968 the Special Assistant for Vietnam Affairs (SAVA) requested the Division to prepare a model for briefing the White House and the DCI. Preliminary meetings with SAVA determined that the model would be built on the AMS 1:50,000 Series L7014 of Vietnam, and AMS file negatives of the desired area were immediately requested. The Division had no model-making capabilities to construct such a detailed model in multiple copies, but it had, on several occasions, requested model production from the Naval Reconnaisance and Technical Support

Center (NRTSC). A contact with NRTSC indicated that they were willing to construct the base model and mold plastic duplicates, but they would be unable to produce the watercoat dye image proofs of the maps to be molded.

The number of copies required had snowballed, and as of that moment over 50 copies were planned for use in Washington and Vietnam. The Agency's reproduction plant had facilities to produce watercoat dye proofs, but not in this quantity. This led to another contact with AMS which agreed to make the map images and added 25 copies for Army use.

The negatives of the AMS 1:50,000 maps were used to produce film positives. As several 1:50,000 map sheets were involved, the Khe Sanh area was obtained by splicing the several positives together into a new single image. Transportation data for the entire map area and the details around the Khe Sanh base were updated, and the drawings were so adjusted. A separate contour image was scribed for NRTSC to use to construct the model, and the spliced drawings were sent to AMS to prepare the 75 proofs on plastic. Both organizations met their deadlines, and two weeks later the dye proofs were transferred from AMS to NRTSC for molding. Less than one month

after SAVA had levied his request, completed plastic models, 40" x 42" in size and in multiple color, were ready for briefing.

[redacted] (b)(1) (b)(3)

Their prime map base, over which they planned operations, was the Air Force Operational Navigation Chart (ONC), 1:1,000,000. For greater accuracy, the ONC's were produced in 8° bands, each band having its own set of standard parallels. Although this made each map sheet of a band more accurate than would be the case with using one set of standard parallels for a large region or continent, sheets from one band could not be matched with sheets of an adjacent band because of the different curvature of their parallels. This feature of the ONC's was continually causing problems for [redacted] (b)(1)e (b)(3) area of collection spanned two ONC sheets. Their question was, "Could anything be done to solve this problem?".

Appropriate Division personnel were assigned to review the problem, and an ad hoc procedure was developed

which resulted in a new map [redacted] produced over a s(b)(1) (b)(3) week period.

The basic plan was to extend one map approximately 10 inches north to cover the desired area of the other map. The problem facing the Division was that of accurately extending the Lambert conformal conic projection, then making the extension appear as part of the original map. Duplicate sets of positives of the two ONC's were ordered from ACIC through Detachment 1 in Arlington, Virginia. Having the positives meant that virtually no work was required on the one sheet which was used intact. The positives of the upper sheets were used in compilation as will be explained.

In 1969 the Division automated cartography program, in the form of Automap, was making great strides, so it was relatively easy to automatically machine plot a very accurate projection extension. This plotted projection was stripped into position on a composite positive of the basic map elements (drainage, boundaries, names, transportation, and contours) and given to the compiler. The ACIC positives of the northern sheet were then photographically changed in size to fit 1° grid squares of the extended projection. The map elements were

then hand-transferred 1^{o} square at a time to a sheet of Cronaflex over the composite positive, which became the manuscript of the new map extension, thus transforming the data from one series of standard parallels to the other.

While the compilation was underway, contact was made with the Naval Oceanographic Office (NAVOCEANO) to obtain their support on a new process they had recently developed from one they had picked up from USGS. The new process was called Scribe Etch, and NAVOCEANO was using it in their chart revision program where major portions of charts to be revised remained intact. The process produced an etched image on yellow scribecoat onto which the revised manuscript was transferred by a dye process. Scribing of the linework was then performed, and the revised areas blended perfectly with the unchanged areas. NAVOCEANO agreed to produce the Scribe Etch scribecoats the Division needed to produce its new map.

Once the compilation of the extended area was completed, a negative of the bottom ONC was produced by PSD and sent to NAVOCEANO for Scribe Etch processing. In the meanwhile, the new compilation was sent to PSD for negative photography, and preparations were made to transfer this image to

the yellow scribecoats on their receipt from the Navy. This process required approximately two weeks to complete.

The Scribe Etch scribecoats were then scribed, element by element, by the draftsmen, matching the ACIC line weights. Even with close examination it was almost impossible to determine where the ACIC map had been extended. To make the match complete, the typography portions of the upper sheet were transferred to stripping film (a thin based, wax-backed photographic material), and the ACIC's actual type was then positioned. Hysometric (equal elevations bands) tones were then produced from the newly scribed contours by the Striprite method, and these were stripped into exact position on the tone positives of the bottom sheet. As a final step, ACIC printing inks were procured from St. Louis, and the final printing [redacted] printed by PSD, appeared to be an ACI (b)(3) produced ONC. [redacted] was jubilant over the results, and another (b)(3) "impossible" request was fulfilled by the ingenuity of Agency cartographers.

III. Conclusion

Thematic cartographic technical developments would not have advanced as forcefully and rapidly as they did without the continued pressing need for thematic maps and associated graphics to support Agency requirements. From the earliest days of the Cartography Division's history, demands always appeared to be beyond the Division's capabilities. The situation grew more serious during and after Admiral Raborn's directorship when graphic-oriented Directors spurred the demand for more cartographic and graphic support. The Division met these challenges by concentrating on ways and means to increase production, and cartographic research and development was the avenue taken to achieve this goal. The Cartographic Lab played a major role in this effort by introducing new aids, techniques, procedures, and equipment to evolve a more efficient production scheme. As a result, greater production at quicker response time was realized, together with an increase in quality. Production records clearly reflect the success the Division had in its efforts. In FY 1952, 970 items were completed compared to 5640 items in FY 1970, with a relatively minor increase in production personnel during the same period.

In the 1960's, support to current intelligence demands for instantaneous response continued to grow. New techniques kept pace with this growth, and by the end of this reporting period the Division was able to respond to the highest level requests at a moment's notice, primarily by its in-house technical support capabilities. The Agency's Cartography Division became the envy of other Intelligence Community organizations, especially DIA, which had great difficulty producing adequate support graphics in the time allotted and in the highly professional manner desired.

The Cartography Division's research and development efforts always enjoyed full backing and support from Office and Division management. However, the success of R&D efforts depended almost entirely on the dynamism and ingenuity of the persons carrying the responsibility at any given time.

The most significant period of development occurred from 1954 to 1964 with a year break between 1962 and 1963. During this period, major advances in scribing and preliminary reproduction support facilities were introduced which completely changed the manner in which thematic map production was handled. A great effort was made during this period to keep abreast of

developments in cartography and in the related fields of lithography and commercial graphics. Lab personnel were given full freedom and encouragement to develop with the minimum of management restrictions, a situation unlike that in other large mapping organizations where red tape and management restraints were deterrents to full personal involvement.

Many technical improvements introduced to the Division were expansions or modifications of developments found at other organizations, where larger research and development staffs had performed most of the preliminary work. This enabled the Cartography Division to take advantage of a much larger R&D effort than it ever could have expended on its own.

In 1968, when the Cartographic Lab was abolished for the want of a suitable Lab man, research and development slowed to a crawl with only the staff of the Technical Support Branch involved. The following two-year period saw several significant developments added to the Division's procedures but only through the major efforts of a few persons who worked in the time to follow up on these finds. In 1970, a Division reorganization increased the production responsibilities of the Technical Support Branch, and even the meager amount of time previously allotted to R&D was drastically cut.

At the end of this reporting period the Cartography Division was in serious need of a revitalization of its research and development effort. Although the basic technical framework was solid, this position would not hold forever, and there were areas which had become antiquated from years of inattention. One of these was the symbol file which had become outdated and did not meet the newly developing design concepts of thematic cartography. The advent of automated cartography, with its tremendous potential to support the Division's needs, was also causing serious concern because of the lack of manpower for developing techniques and procedures to utilize plotter and digitizer output to its full potential. For many years the Cartography Division had enjoyed a position of unquestioned leadership in the technical thematic cartography field. By late 1970 the outlook for research and development was bleak, and this position of leadership was in jeopardy of being lost.

Comment on Sources

The research on this report was hampered by the lack of complete administrative and technical files for the reporting period. Fortunately, the author lived through most of the period and was closely associated with the technical aspects of thematic map production. His memory and personal files filled in many details missing from official records. A considerable amount of pertinent data was extracted from Cartography Division monthly reports, January 1945 through December 1959, the Cartographic Lab experimental file which covered the period from July 1954 through October 1964,* and numerous trip reports. Interviews with present and former Cartography Division personnel accounted for another significant bloc of information. The most important of these was the series of interviews with Mr. [redacted] former Division Chief, who was very technically oriented and encouraged many of the developments cited. (b)(3) (b)(6)

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* Records Center Archival File, OBGI, Cartography Division, Item 71-437.

Approved for Release: 2019/04/19 C06729281

LEROY PEN GAUGE

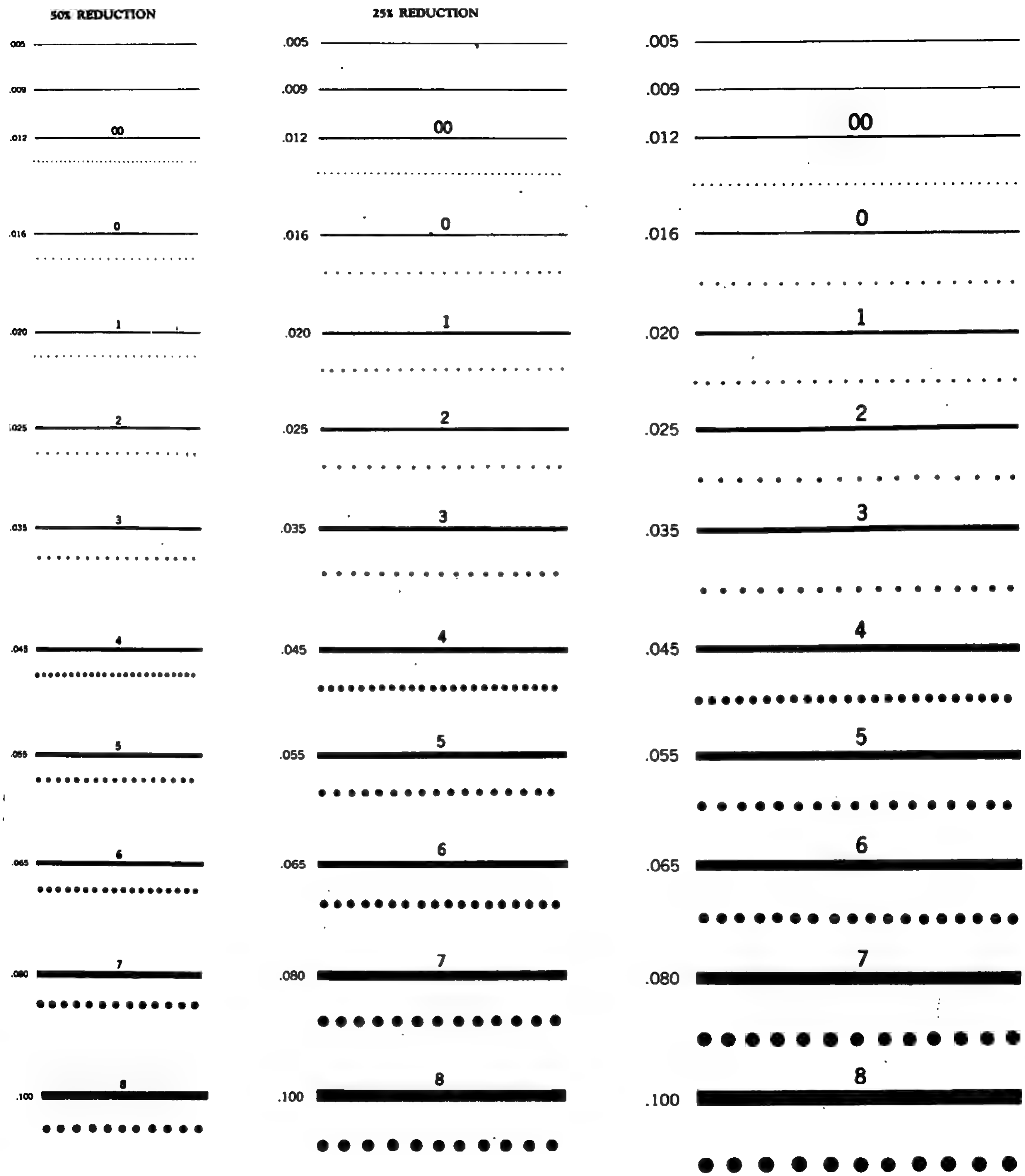


Figure 1. Line weight guide

NEWS GOTHIC

Average Number of Characters Per Inch	
	6 Point
16	MEDITERRANEAN CASPIAN URAL'SK PHILIPPINES MOSCOW ATLANTIC OCEAN LONDON NORWEGIA
20	Mediterranean Caspian Ural'sk Philippines Moscow Atlantic Ocean London Norwegian Sea 24680500
	8 Point
14	MEDITERRANEAN CASPIAN URAL'SK PHILIPPINES MOSCOW ATLANTIC OCEAN LONDO
18	Mediterranean Caspian Ural'sk Philippines Moscow Atlantic Ocean London Norwegian S 2
	10 Point
11	MEDITERRANEAN CASPIAN URAL'SK PHILIPPINES MOSCOW ATLANTIC O
14	Mediterranean Caspian Ural'sk Philippines Moscow Atlantic Ocean L 2568
	12 Point
10	MEDITERRANEAN CASPIAN URAL'SK PHILIPPINES MOSCOW ATL
13	Mediterranean Caspian Ural'sk Philippines Moscow Atlantic Oc 46
	14 Point
8	MEDITERRANEAN CASPIAN URAL'SK PHILIPPINES MO
11	Mediterranean Caspian Ural'sk Philippines Moscow A 24
	18 Point
7	MEDITERRANEAN CASPIAN URAL'SK PHILIF
9	Mediterranean Caspian Ural'sk Philippin 246
	24 Point
5.5	MEDITERRANEAN CASPIAN URAL'S
7	Mediterranean Caspian Ural'sk P24
	30 Point
4.5	MEDITERRANEAN CASPIAN L
5.5	Mediterranean Caspian U246

Figure 2. Sample type guide

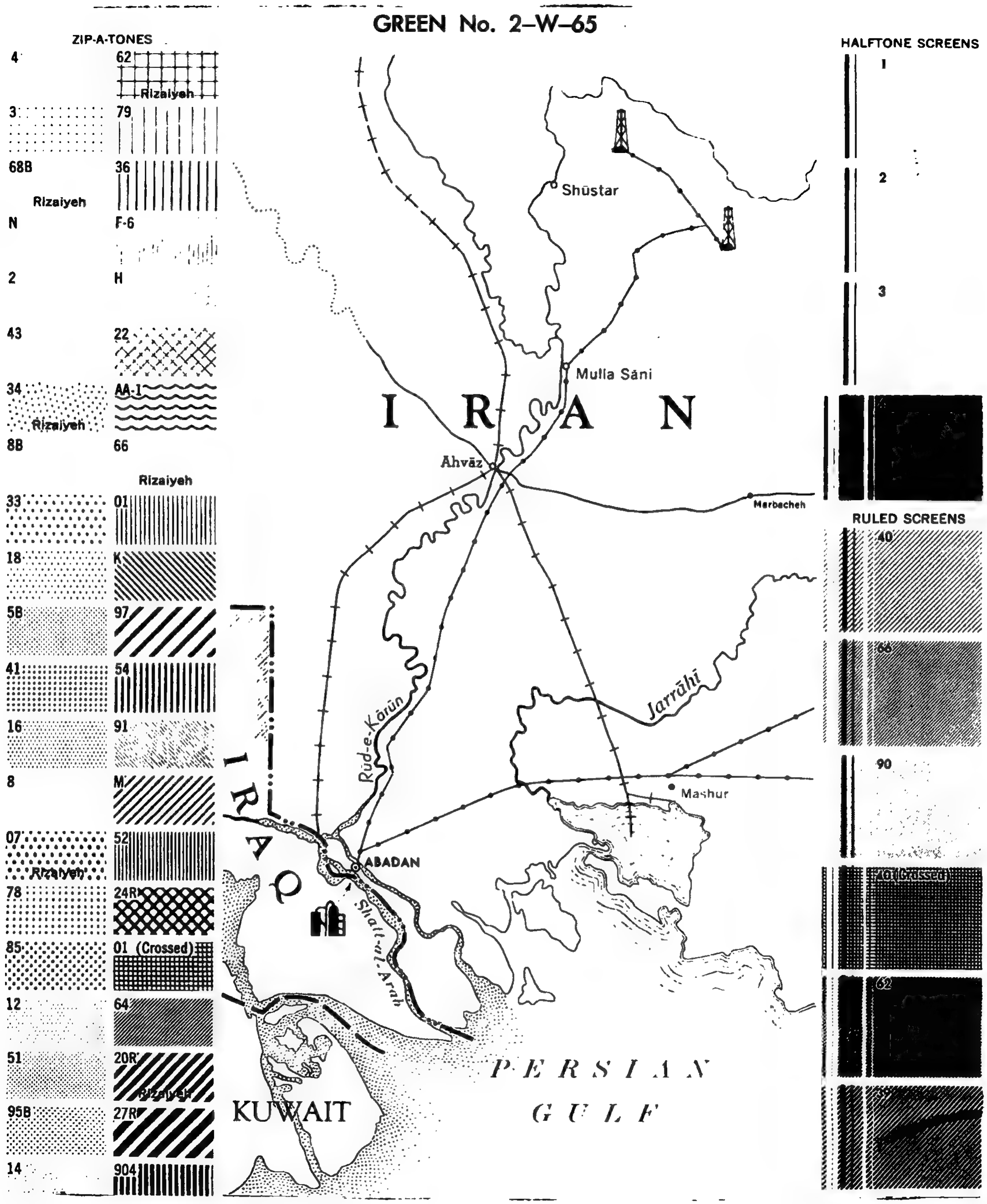


Figure 3. Sample color guide

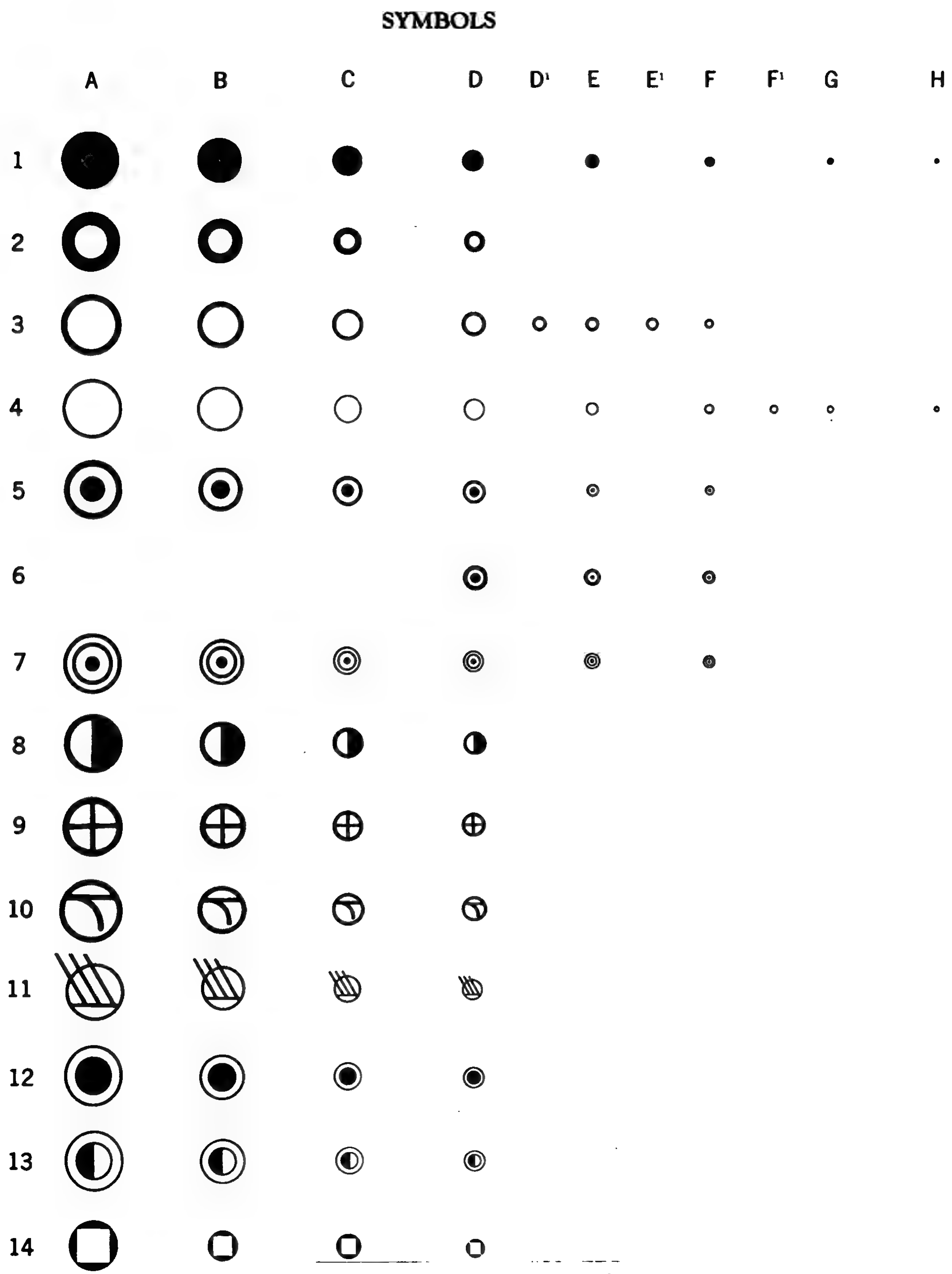


Figure 4. Sample symbol guide

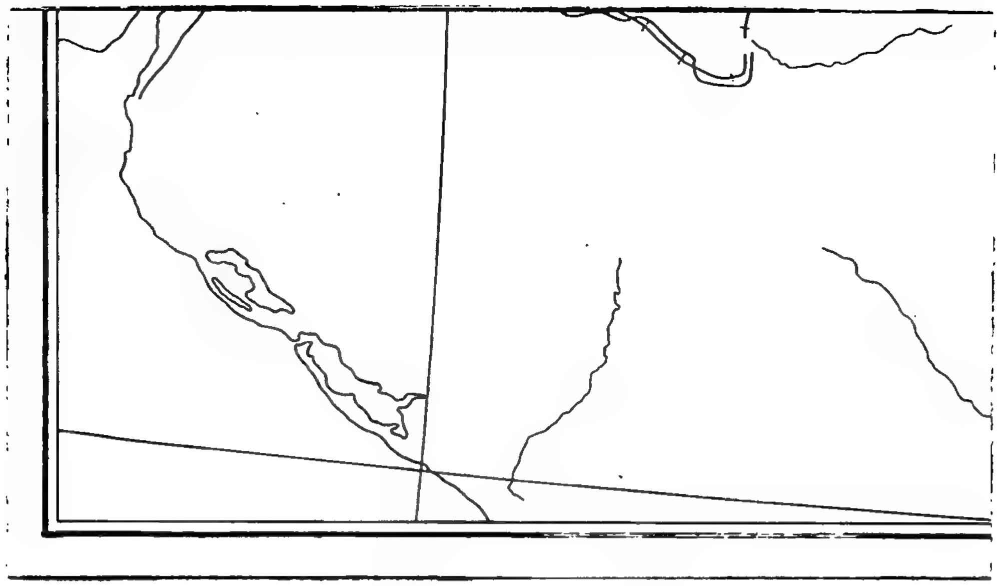


Figure 5. K & E Scribecoat (white). Note how left half of scribed image appears as inked lines when backed with black.

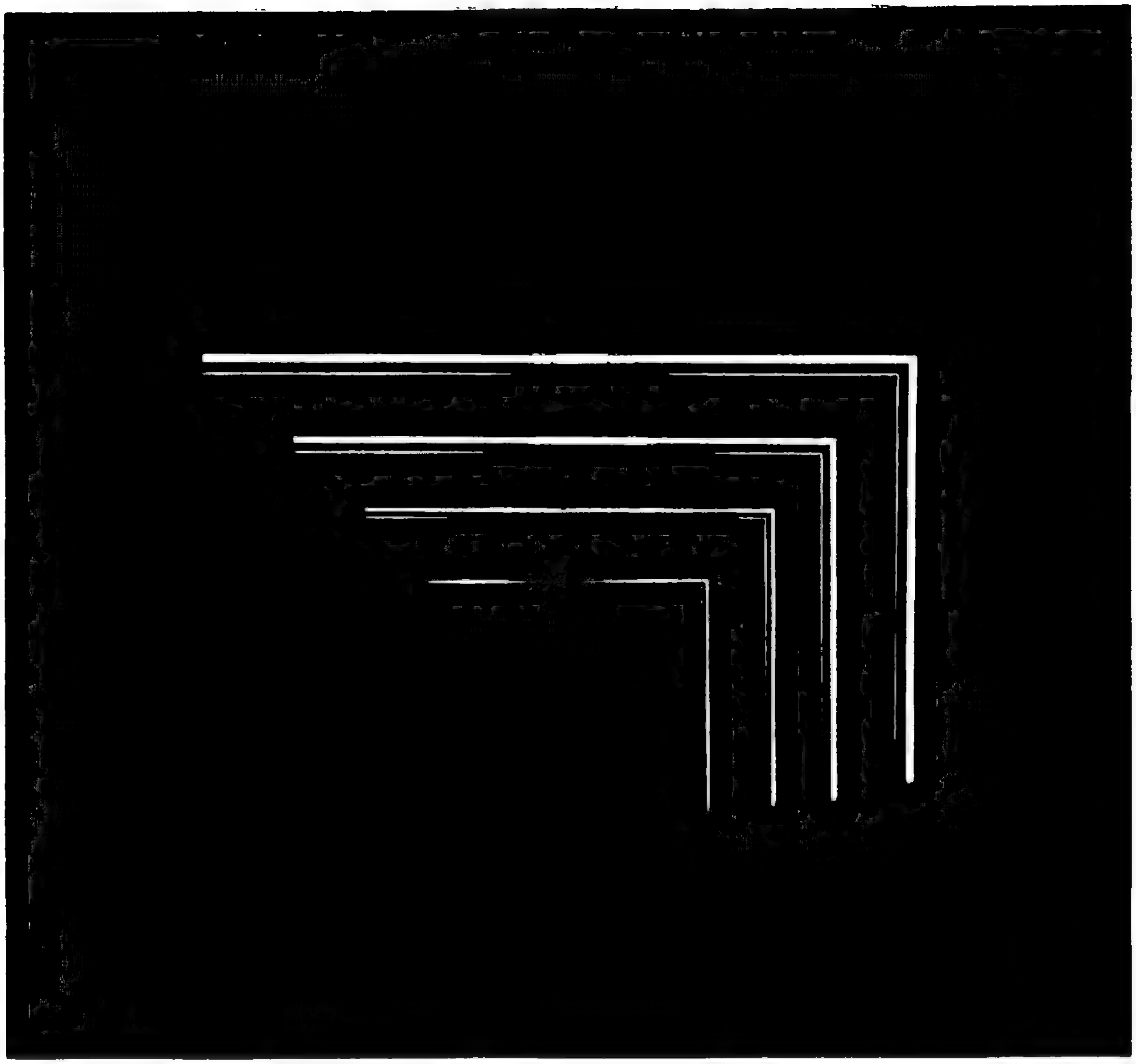


Figure 6. Samples of various combinations of double lines produced by one stroke of specially milled sapphire cutters.

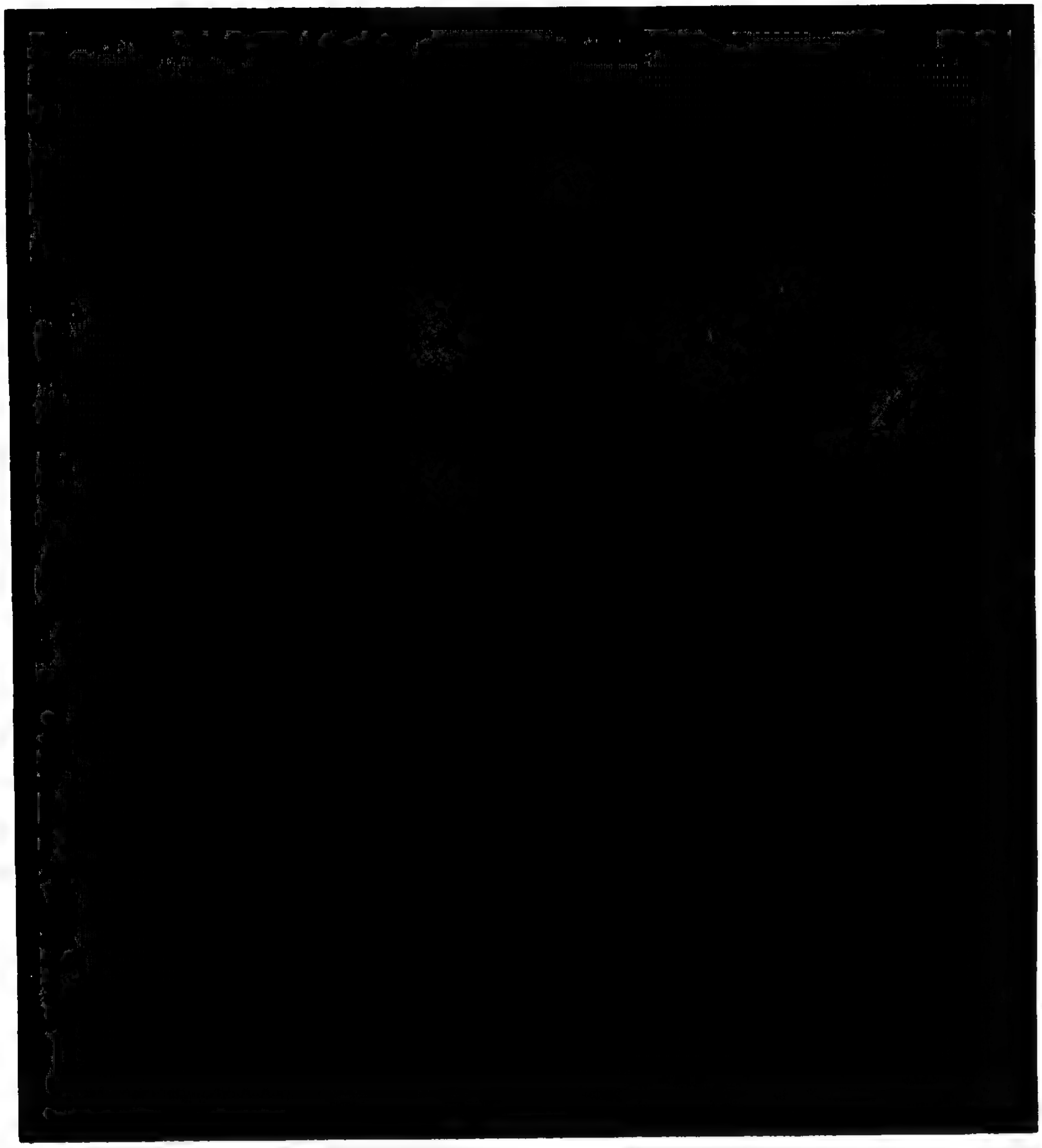
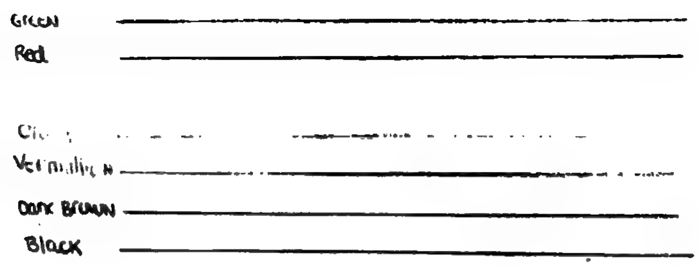


Figure 7. K & E Helio Scribecoat (rust). Manuscript image is transferred to Helio scribecoat by carbon arc exposure and ammonia vapor development. Image is scribed in reverse to produce a true negative.

Figure 8. Direct Reproduction Striprite. Negative or positive is produced by stripping coating from base. One half of sample is stripped to demonstrate the technique.



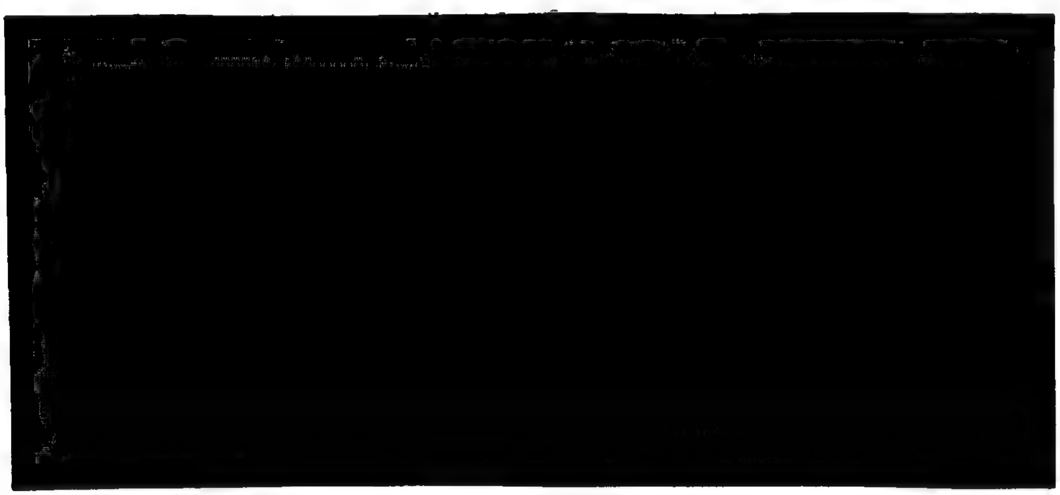


Figure 9. Top sample shows pencil lines as they appear on manuscript. Bottom sample shows quality of line produced when transferred to scribecoat. Note the illogical results—yellow a better image than red.

ACCENTS

GROUP 3—For use with GO, Ionic, and CGSI.

NOTE: In each case use next size smaller accent with CGSI.

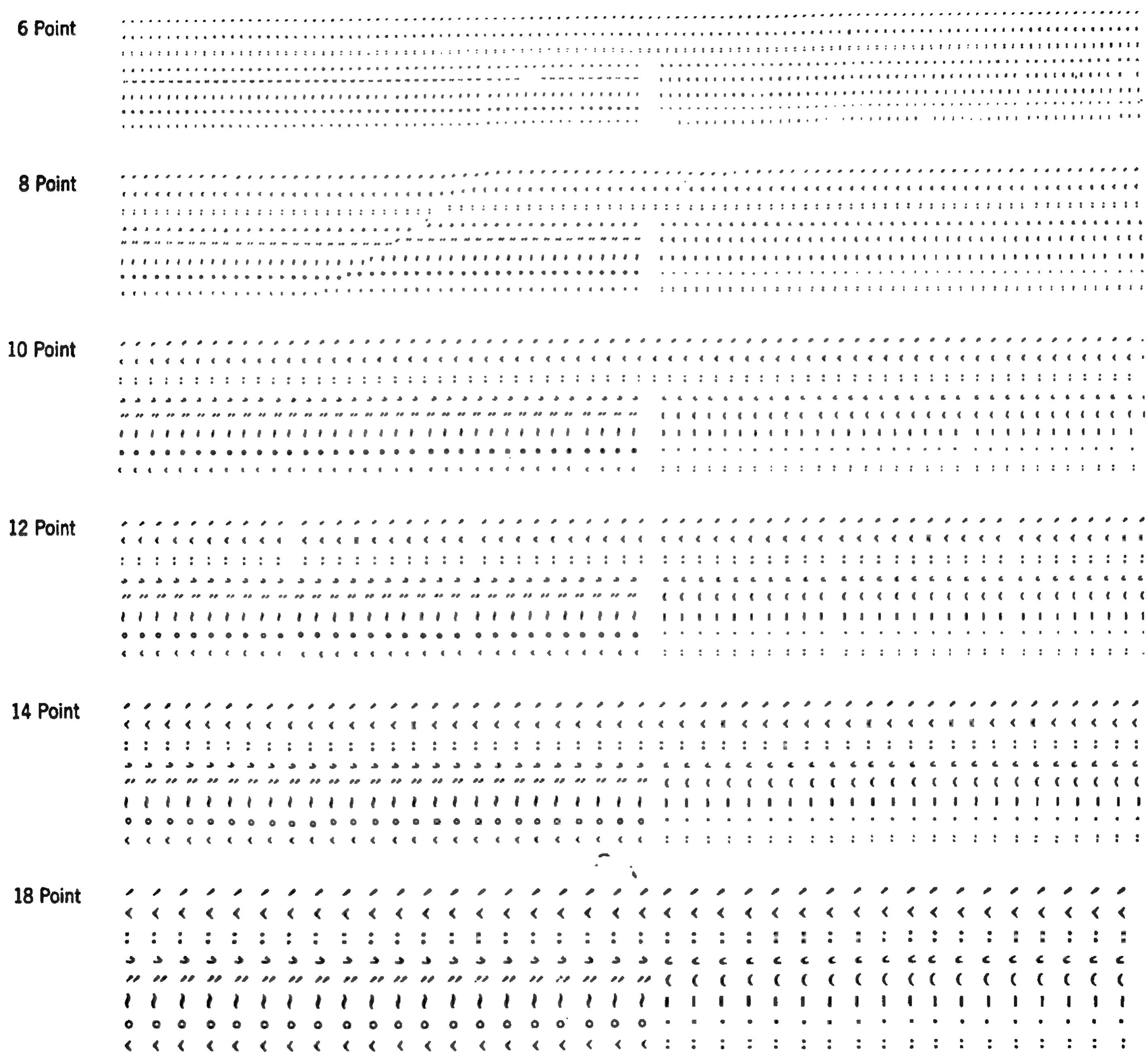


Figure 10. Sample accent sheet

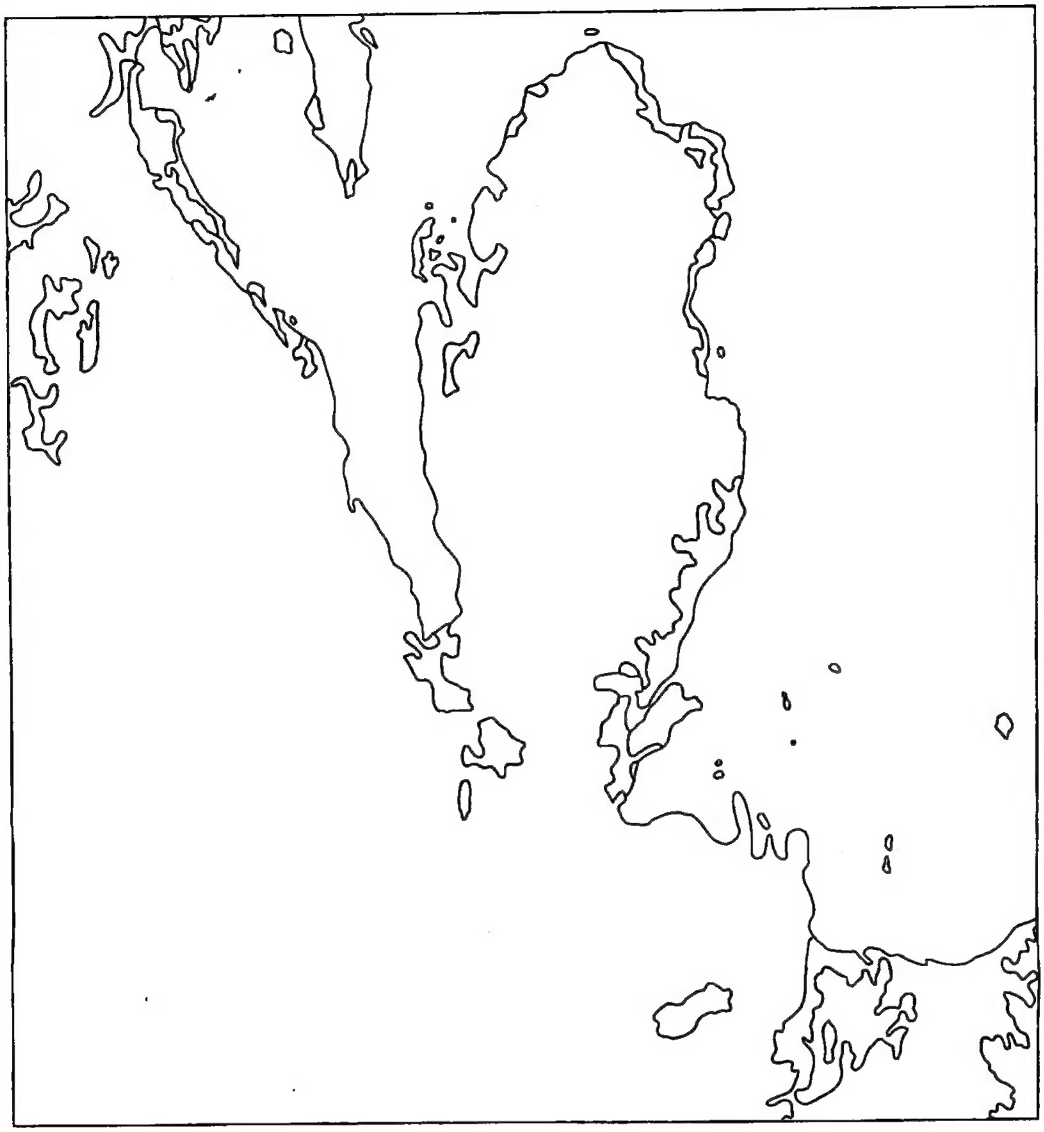


Figure 11. Kodagraph Wash-Off Film. The high quality image equals any produced by conventional darkroom processes.

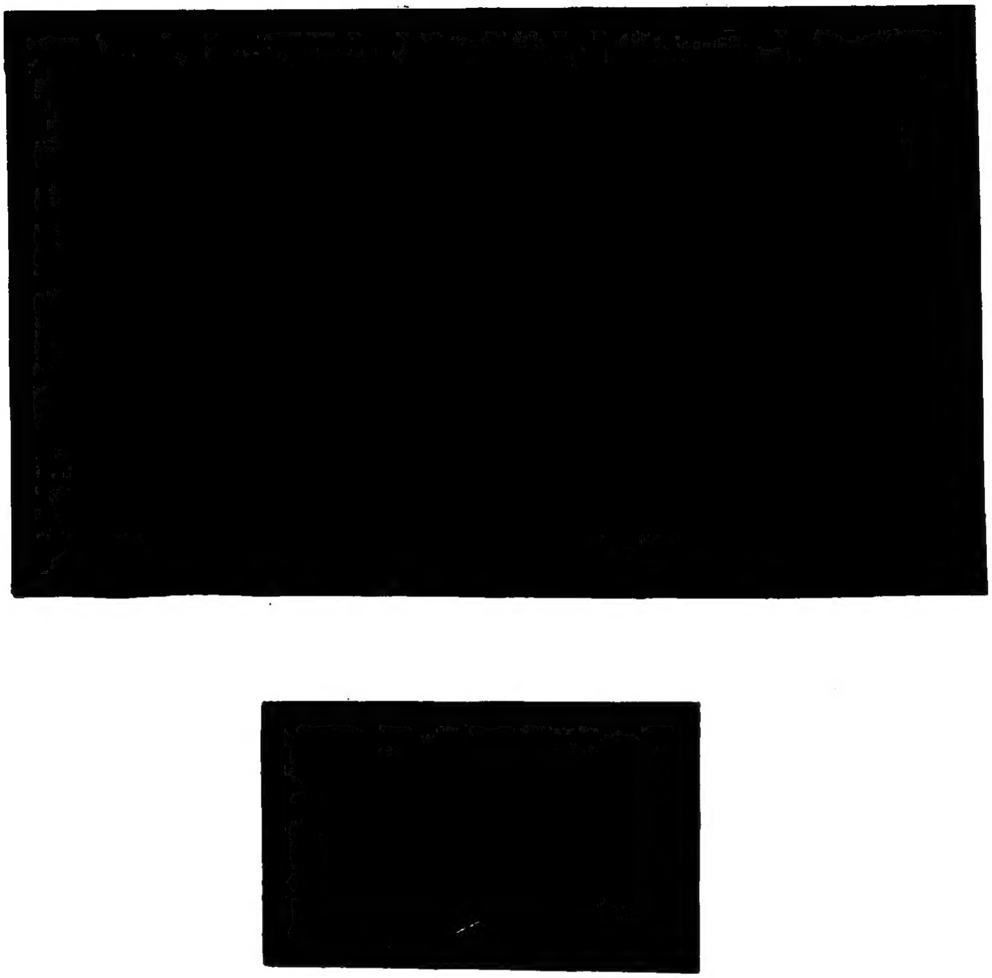


Figure 12. K & E Duplication Scribecoat. The four images of Cyprus were produced by a simple exposure of the scribed image below in their predetermined positions. Exact duplication of detail is assured by this method, while scribing each image individually would result in minor discrepancies from one image to the other.

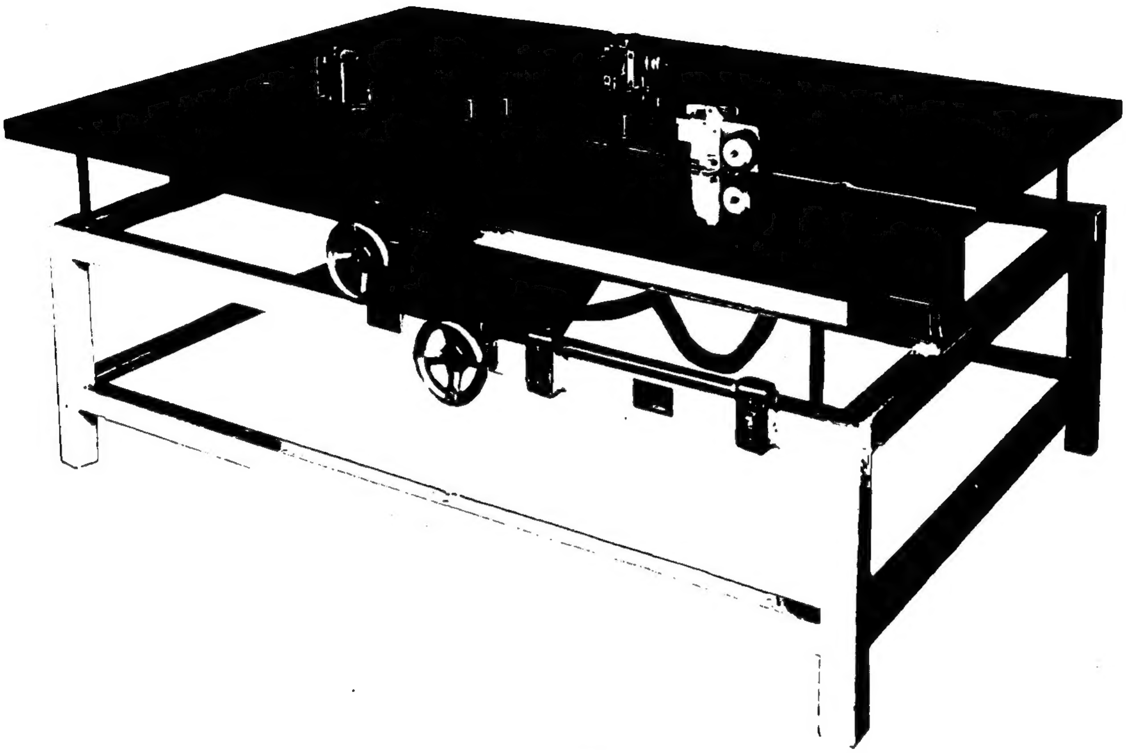


Figure 13. Moffett Slot Register Punch

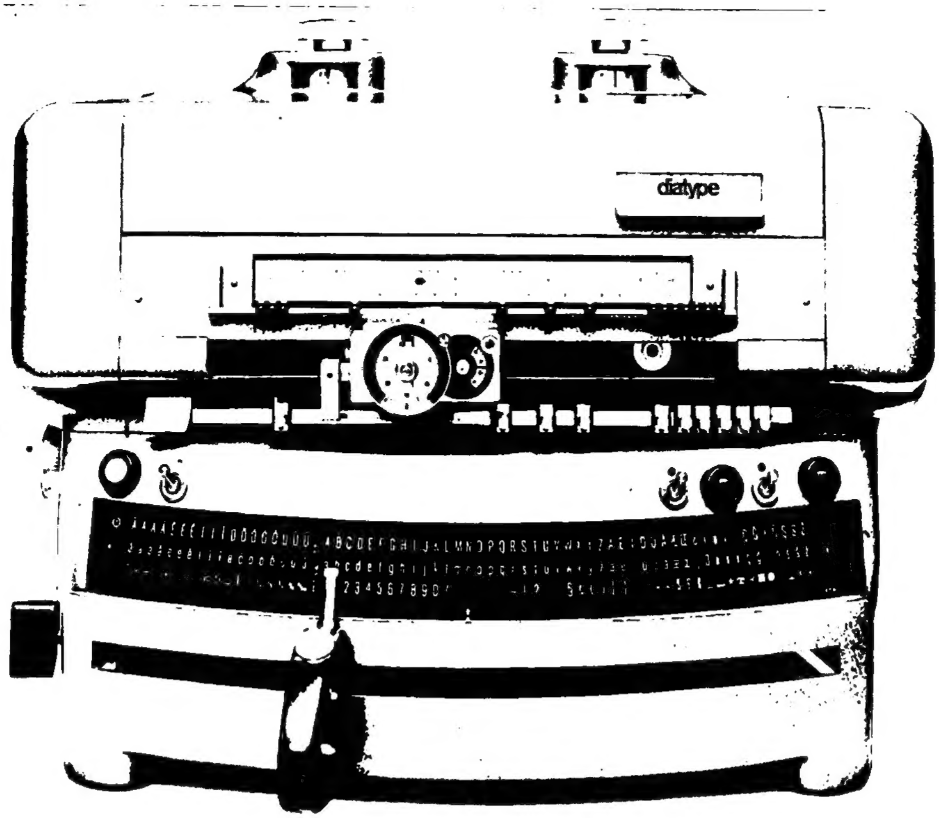


Figure 14. Diatype Photoc[illegible]g Machine